

UNITED STATES
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA

SPECIFICATIONS
FOR
MECHANICAL/ELECTRICAL MODIFICATIONS
CENTRAL COMPUTING COMPLEX

BUILDINGS 1268, 1268A, 1268B, and 1268C

LOCATED IN
WEST AREA

LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA

PROJECT TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

01010 SUMMARY OF WORK
01011 GENERAL AND ADMINISTRATIVE REQUIREMENTS
01060 LANGLEY SAFETY AND ENVIRONMENTAL REQUIREMENTS
01330 SUBMITTALS
01420 SOURCES FOR REFERENCE PUBLICATIONS

DIVISION 15 - MECHANICAL

15003 GENERAL MECHANICAL PROVISIONS
15050 BASIC MECHANICAL MATERIALS AND METHODS
15055 MECHANICAL WELDING
15080 MECHANICAL INSULATION
15125 STEAM TRAPS
15626 CENTRIFUGAL WATER CHILLERS
15628 ABSORPTION WATER CHILLERS
15720 AIR HANDLING UNITS
15818 MEDIUM/HIGH PRESSURE DUCTWORK
15950 TESTING, ADJUSTING AND BALANCING
15972 DIRECT DIGITAL CONTROL SYSTEMS (DDC)

DIVISION 16 - ELECTRICAL

16003 GENERAL ELECTRICAL PROVISIONS
16124 MEDIUM VOLTAGE CABLE
16145 STANDARD WIRING SYSTEMS
16225 MOTORS
16286 OVERCURRENT PROTECTIVE DEVICES
16345 MOTOR CONTROL

-- End of Project Table of Contents --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

1.2 DRAWINGS

1.2.1 Contract Drawings

1.3 LOCATION OF WORK

1.4 SCHEDULE

1.4.1 General Schedule Requirements

1.4.2 Special Work Scheduling Requirements

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under these specifications consists of Mechanical and Electrical modifications at Building 1268A, 1268B & 1268C, 2 South Wright Street, West Area, of the Langley Research Center.

The Contractor shall furnish all plant, equipment, tools, materials, labor and services necessary for or incidental to a complete and finished job as shown on the drawings listed below and as specified herein.

All references to the Contracting Officer contained in this specification, or any severable part thereof, shall be determined to mean the Contracting Officer or the Contracting Officer's Technical Representative. If any question arises concerning the "authorization" status of a Contracting Officer Technical Representative, the Contractor shall immediately refer the question, in writing, to the Contracting Officer. Any references to "approved by", "witnessed by", or "submitted to", shall be determined to mean the Contracting Officer.

Where "as indicated" and "as specified" are written it shall refer to "as indicated on the drawings," and "as specified in the specifications". The specifications will always take precedence over the drawings.

Where "day" or "days" are written it shall mean calendar day or days, unless otherwise stated in the specification.

Where "hour" or "hours" are written it shall mean clock hours, unless otherwise stated in the specification.

The work to be performed includes, but is not limited to, the following:

WORK PACKAGE 1 - BASE BID ITEM:

The work consists of the replacement of existing Air Handling Units (AHU) 1, 5, and 5A located in the basements of Buildings 1268 and 1268A. Included are the dismantling and removal of existing equipment and associated construction (including removal of some asbestos containing materials) and providing new replacement AHUs, complete with new piping, ductwork, electrical connections and controls.

WORK PACKAGE 2 - BASE BID ITEM:

The work consists of the removal of existing Chillers 5 and 6, located in Building 1268B, and the replacement of Chiller 6. The Contractor shall furnish and install the new chiller, complete with new piping,

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

electrical connections, and controls.

WORK PACKAGE 4 - BASE BID ITEM:

The work consists of replacing motor control centers located in the basement of Building 1268A and includes the following:

1. Furnishing of replacement motor controls centers that conform to the specifications and drawings.
2. Identification of and labeling of existing wiring, raceways, and associated equipment.
3. Disconnection of existing wiring and conduit.
4. Removal and disposal of wire and conduit that is not being utilized in the replacement motor control center.
5. Removal and disposal of existing motor control centers.
6. Installation of new motor control center. Includes installing new wiring and conduit as necessary and reconnecting existing wiring and conduit.
7. Creating documentation for new installation as specified.
8. Testing new system to ensure that all equipment is in proper working order.

WORK PACKAGE 3 - ADDITIVE BID ITEM:

The work consists of providing a back-up chiller for Building 1268C, complete with new piping, electrical connections, and controls.

1.2 DRAWINGS

After contract award, a maximum of five sets of full size contract drawings will be furnished to the Contractor without charge.

1.2.1 Contract Drawings

The work shall conform to these specifications and the drawings listed below:

<u>DRAWING NO.</u>	<u>REV.</u>	<u>SHEET NO.</u>	<u>TITLE</u>
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WORK PACKAGE 1 - BASE BID ITEM:

1238625	-	T1	Title Sheet
1238626	-	WP1-M1	AHU-1, 5 & 5A Mechanical Demolition Plans
1238627	-	WP1-M2	AHU-1, 5 & 5A Mechanical New Work Plans, Sections and Schedules

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

<u>DRAWING NO.</u>	<u>REV.</u>	<u>SHEET NO.</u>	<u>TITLE</u>
1238628	-	WP1-M3	AHU-1, 5 & 5A Mechanical Details, Diagrams and Sequence of Controls
1238629	-	WP1-E1	AHU-1, 5 & 5A Existing and New One-line Diagrams
1238630	-	WP1-E2	AHU-1 Demolition Plan and Details
1238631	-	WP1-E3	AHU-5 & 5A Demolition Plans and Details
1238632	-	WP1-E4	AHU-1 New Work Plan
1238633	-	WP1-E5	AHU-5 & 5A New Work Plan

WORK PACKAGE 2 - BASE BID ITEM:

1238634	-	WP2-M1	Chillers 5 & 6 Mechanical Demolition Plan
1238635	-	WP2-M2	Chiller 6R Mechanical New Work Plan
1238636	-	WP2-M3	Chiller 6R Mechanical Details, Schedules & Sequence of Controls
1238637	-	WP2-E1	Existing and New One-Line Diagrams
1238638	-	WP2-E2	Chillers 5 and 6 Demolition Plan
1238639	-	WP2-E3	Chiller New Work Plan

WORK PACKAGE 4 - BASE BID ITEM:

764137	-	WP4-E1	A-MCC-A & A-MCC-A1 Demolition One-Line Diagrams
764138	-	WP4-E2	A-MCC-A & A-MCC-A1 Demolition Plan and Elevations
764139	-	WP4-E3	A - MCC -A Existing Schematics 1
764140	-	WP4-E4	A - MCC -A Existing Schematics 2
764141	-	WP4-E5	A - MCC -A1 Existing Schematics
764142	-	WP4-E6	A-MCC-A & A-MCC-A1 Existing Wiring Diagrams
764143	-	WP4-E7	A-MCC-A & A-MCC-A1 New One-Line Diagram
764144	-	WP4-E8	A-MCC-A & A-MCC-A1 New Work Plans and Elevations
764145	-	WP4-E9	A - MCC -A New Work Schematics - Sheet 1
764146	-	WP4-E10	A - MCC -A New Work Schematics - Sheet 2
764147	-	WP4-E11	A - MCC -A1 New Work Schematics

WORK PACKAGE 3 (ADDITIVE BID ITEM):

795343	-	WP3-M1	Back-Up Chiller Mechanical Installation Plan and Notes
795344	-	WP3-M2	Back-Up Chiller Mechanical Isometric and Details
795345	-	WP3-M3	Back-Up Chiller Mechanical Schedule and Sequence of Controls
795346	-	WP3-E1	Back-Up Chiller Electrical Demolition

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

<u>DRAWING NO.</u>	<u>REV.</u>	<u>SHEET NO.</u>	<u>TITLE</u>
			& New Work Plans
795347	-	WP3-E2	Back-Up Chiller New Work One-Line Diagram and Details
795348	-	WP3-E3	Back-Up Chiller Control Schematic Diagrams

1.3 LOCATION OF WORK

The work to be done under these specifications is located in the West Area of Langley Research Center, as indicated on Contract Drawing 1238625.

1.4 SCHEDULE

1.4.1 General Schedule Requirements

The Contractor shall commence work within ten (10) calendar days after date of receipt of Notice to Proceed. All work as required by these specifications shall be completed within 180 consecutive calendar days after date of receipt of Notice to Proceed.

1.4.2 Special Work Scheduling Requirements

The Contractor shall ensure all equipment and materials required for a complete installation are on-site prior to beginning any work requiring a facility shutdown period. Additional scheduling and facility system shutdown requirements for each work package are as follows:

Work Package 1:

All work requiring that the air handlers be out of service shall be scheduled after September 30 and before May 1 of the calendar year to avoid having the facility without operational air handlers during the peak cooling season. Other than cooling season requirements, work on replacement of air handlers may be conducted at any time with respect to scheduling other portions of the work.

The work shall be accomplished so that each air handling unit is off line no longer than 30 calendar days for replacement. The Contractor shall schedule air handler shutdowns in advance with the Contracting Officer.

Work Package 2:

The facility indicates that they have sufficient chiller capacity for this work to be scheduled at any time during the project.

The work may be done at any time; but, the Contractor shall arrange the necessary shutdown with the Contracting Officer in advance. The Government will shut down the chillers to be removed and isolate them from the building system prior to the Contractor draining the chillers and commencing removal operations.

Work Package 3, Additive Bid Item:

Cooling water to 1268C shall remain in service during the course of the work. To complete installation of the new back-up chiller in 1268C requires switching the 1268C cooling water system from Chiller 7, the existing chiller in 1268C, over to the 1268 central cooling system and taking Chiller 7 off line. 1268C can be switched over to cooling water from the chillers in 1268B by manually opening two valves. The Government will switch the cooling water system over at a prearranged time and the Contractor shall perform the electrical tie-in of the new equipment and chiller shakedown testing during the scheduled switch over to the 1268 central system.

The change over to the 1268 central cooling system for connecting the new back-up chiller in 1268C shall not take place during the shutdown required for Work Package 4, replacement of the Motor Control Center.

Work Package 4:

Work requiring system outage shall not be performed during the peak cooling season specified for Work Package 1. Replacement of the motor control center shall not be performed while the cooling water system for 1268C is switched over to or dependent on the central cooling system for the 1268 complex.

The change-out of equipment requires a shutdown of the central cooling system for the 1268 complex, except for 1268C. The work shall be accomplished during a shutdown period not to exceed three consecutive calendar days and to be accomplished over a weekend plus a regularly scheduled Government holiday occurring on the following Monday. The Contractor shall schedule the required shutdown with the Contracting Officer 21 calendar days in advance. The Government and the Contractor shall jointly conduct a pre-inspection to ensure that all required new equipment is on site prior to commencing the shutdown and taking the existing motor control center off line.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01011

GENERAL AND ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

- 1.1 SUMMARY
- 1.2 SUBMITTALS
- 1.3 PRECONSTRUCTION CONFERENCE
- 1.4 PROJECT MEETINGS
- 1.5 SECURITY REQUIREMENTS AND REGULATION OBSERVANCE
 - 1.5.1 References
 - 1.5.2 Identification Badges
- 1.6 SCHEDULING OF WORK
- 1.7 ADDRESSING CORRESPONDENCE, SUBMITTALS AND INVOICES
- 1.8 SCHEDULE OF CONSTRUCTION, MONTHLY PROGRESS SCHEDULES AND MONTHLY TECHNICAL PROGRESS NARRATIVES
 - 1.8.1 Schedule of Construction
 - 1.8.2 Monthly Progress Schedules and Monthly Technical Progress Narratives
 - 1.8.2.1 Monthly Progress Schedules
 - 1.8.2.2 Monthly Technical Progress Narratives
- 1.9 AS-BUILT CONTRACT DRAWINGS
- 1.10 OPERATION AND MAINTENANCE (O&M) MANUAL
- 1.11 PRICE BREAKDOWN FOR DETERMINING PROGRESS PAYMENTS
- 1.12 PRICE BREAKDOWN FOR MODIFICATION PROPOSALS
- 1.13 MINIMUM EMPLOYEE COMPENSATION
- 1.14 CONTRACTOR RELEASE FORM
- 1.15 BULLETIN BOARD
- 1.16 ORDER STATUS REPORTS
- 1.17 MATERIALS AND EQUIPMENT
- 1.18 MATERIAL AND EQUIPMENT INSTALLATION
- 1.19 HANDLING/PROTECTION OF CONTRACTOR MATERIAL AND EQUIPMENT
- 1.20 ON-SITE CLEAN-UP AND DISPOSAL OF MATERIALS
- 1.21 UTILITY OUTAGES AND POWER CONNECTIONS
 - 1.21.1 Utility Outages
 - 1.21.2 Application for Connecting to Government Electrical Utilities
- 1.22 USE OF GOVERNMENT PREMISES
 - 1.22.1 Boundaries and Site Requirements
 - 1.22.2 Adjacent Premises and Existing Services
 - 1.22.3 Vehicle Weight Limits
- 1.23 BARRICADES AND TRAFFIC CONTROL
- 1.24 ON-SITE UTILITIES
 - 1.24.1 Water
 - 1.24.2 Electrical Power

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

1.24.3 Telephone Service

- 1.25 ON-SITE WATER CONTAMINATION
- 1.26 ON-SITE GOVERNMENT/CONTRACTOR/SUBCONTRACTOR COORDINATION
- 1.27 SANITARY CONVENIENCES
- 1.28 PLUMBING WORKERS' QUALIFICATIONS
- 1.29 ELECTRICAL WORKERS' QUALIFICATIONS
- 1.30 MECHANICAL WORKERS' QUALIFICATIONS
- 1.31 INSPECTION RECORDS

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01011

GENERAL AND ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

This section covers Langley Research Center's unique general and administrative requirements.

1.2 SUBMITTALS

The Contractor shall submit the following in accordance with Section 01330, Submittals:

SD-04 Drawings

As-Built Contract Drawings

SD-08 Statements

Materials and Equipment Substitutions

Application for Making Connection to Utilities

Utility Outage Requests

Plumbing Worker's Qualifications

Electrical Worker's Qualifications

Mechanical Worker's Qualifications

SD-18 Records

Invoices

Contractor Release Form

Price Breakdown for Modification Proposals

Price Breakdown for Progress Payments

Order Status Reports

Schedule of Construction

Monthly Progress Schedules

Monthly Technical Progress Narrative

Certified Payrolls

SD-19 Operation and Maintenance Manuals

1.3 PRECONSTRUCTION CONFERENCE

The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer. Work on-site shall not commence prior to the conference. Subcontractor representatives may attend.

Discussion will address project orientation, key points of contact, safety issues, permits, the on-site location of the Contractor's office, if any, and other pertinent issues. The Contractor shall be prepared to review and discuss the specifications and drawings with the Contracting Officer to resolve any post award questions prior to construction start.

1.4 PROJECT MEETINGS

The Contractor shall attend bi-weekly project meetings scheduled by the Contracting Officer. Subcontractor representatives may attend.

1.5 SECURITY REQUIREMENTS AND REGULATION OBSERVANCE

1.5.1 References

The publications listed below form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only.

LAPD 1600.3	(March 2000) Langley Research Center Security Policy
LAPD 1600.4	(August 1999) Firearms and Dangerous Weapons Policy
LAPD 1600.5	(August 1999) Workplace Violence and Threatening Behavior
LAPD 1700.7	(March 2001) Traffic Management
LAPD 1700.8	(June 1999) Parking Regulations
NPG 1371.2	(April 1999) Procedures and Guidelines for Processing Request for Access to NASA by Foreign Nationals or Representatives

1.5.2 Identification Badges

At all times while on LaRC property, the Contractor shall require its employees, subcontractors and agents to wear badges which will be issued by the NASA Contract Badge and Pass Office, located at 1 Langley Boulevard (Building No. 1228). Badges shall be issued only between the hours of 6:30 a.m. and 3:30 p.m., Monday through Friday. Temporary ID badges will be

issued upon submission of a completed Langley Form 227, "Construction/Contractor Badge and/or Vehicle Permit Request". The Contractor will be held accountable for these badges and may be required to validate outstanding badges with the NASA LaRC Security Office. Immediately after employee termination or contract completion, badges shall be returned to the NASA Contract Badge and Pass Office.

1.6 SCHEDULING OF WORK

The established hours of work at Langley Research Center are 7:00 a.m. to 4:30 p.m. Monday through Friday, excluding U.S. Government holidays and closings declared by Administrative or Executive Order.

In order that the necessary and proper inspection of the Contractor's work may be effectively accomplished, and to assure the availability of required Government facilities, the Contractor shall schedule work performance to be compatible with the established work week, hours of work and legal holidays observed by the Government organization having cognizance over the work performed at the particular work site. No work shall be performed during other hours without prior authorization of the Contracting Officer.

All requests for overtime work shall be submitted to the Contracting Officer or the Contracting Officer's authorized representative two calendar days prior to the proposed overtime.

The Contractor shall give at least three calendar days notice to the Contracting Officer and the Safety and Facility Assurance Office of the date when the contract work will begin at the site.

If the Contractor suspends work at any time, it shall notify the Construction Inspection Service (CIS) and shall not again resume work without notifying the CIS in advance.

1.7 ADDRESSING CORRESPONDENCE, SUBMITTALS AND INVOICES

All correspondence, submittals and invoices shall be clearly marked with the assigned Government contract number. Unless otherwise specified herein, the Contractor shall submit an original and five copies of all correspondence and submittals.

The Contractor shall submit all shop drawings, test reports, equipment data sheets, and any other technical data under an original cover letter and with copies as required by these specifications. Samples shall be accompanied by a cover letter and appropriate copies.

Correspondence and submittals shall be addressed to the designated Government addressee(s) and mail stop(s) shown in the Submittal Summary of Section 01330 to the following address:

All correspondence to the Contracting Officer or Contract Administrator shall be addressed as follows:

Contracting Officer/Contract Administrator, Mail Stop 126
Contract NAS1- _____

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

NASA, Langley Research Center
Hampton, Virginia 23681-0001

All correspondence to the Contracting Officer Technical Representative (COTR) shall be addressed as follows:

COTR, Mail Stop 465
Contract NAS1- _____
NASA, Langley Research Center
Hampton, Virginia 23681-0001

Progress payment, final payment invoices, and Contractor's release form (NASA Form 778) shall be addressed as follows:

Accounts Payable and Employee Services Branch, Mail Stop 175
Contract NAS1- _____
NASA, Langley Research Center
Hampton, Virginia 23681-0001

Certified payrolls shall be addressed as follows:

Construction Services Unit, Mail Stop 428
Contract NAS1- _____
NASA, Langley Research Center
Hampton, Virginia 23681-0001

Submittals to the Safety and Facility Assurance Office shall be addressed as follows:

Safety and Facility Assurance Office, Mail Stop 429
Contract NAS1- _____
NASA, Langley Research Center
Hampton, Virginia 23681-0001

Submittals to the Environmental Management Office shall be addressed as follows:

Environmental Management Office, Mail Stop 418
Contract NAS1- _____
NASA, Langley Research Center
Hampton, Virginia 23681-0001

1.8 SCHEDULE OF CONSTRUCTION, MONTHLY PROGRESS SCHEDULES AND MONTHLY TECHNICAL PROGRESS NARRATIVES

1.8.1 Schedule of Construction

Within 30 calendar days after date of receipt of Notice to Proceed, the Contractor shall submit to the Contracting Officer for approval, 6 copies of a practical and feasible schedule of construction on Form LF-107, Contract Progress Schedule Report (Attachment 1). This schedule shall indicate the sequence of work the Contractor plans to complete the contract within the specified completion period and shall include, as a minimum, the following categories of work:

WORK PACKAGE 1:

Safety plan submittal
Mobilization
Removal of asbestos containing material
Removal of air handling units
Installation of new air handling units
Piping
Ductwork
Electrical connections
Controls
Start-up and testing
Punch list
Site cleanup
Demobilization
As-built drawings

WORK PACKAGE 2:

Safety plan submittal
Mobilization
Asbestos abatement
Removal of chillers
Installation of new chiller
Piping
Electrical connections
Controls
Start-up and testing
Punch list
Site cleanup
Demobilization
As-built drawings

WORK PACKAGE 3 (Additive Bid Item):

Safety Plan submittal
Mobilization
Installation of new chiller
Piping
Electrical connections
Controls
Start-up and testing
Punch list
Site cleanup
Demobilization
As-built drawings

WORK PACKAGE 4:

Safety Plan submittal
Mobilization
Removal of existing motor control centers

Installation of new motor control centers
motor control centers
Controls
Start-up and testing
Punch list
Site cleanup
Demobilization
As-built drawings
Project milestones and critical long lead time components

Upon Contracting Officer approval of the schedule of construction, the Contractor shall utilize this approved schedule for its contract progress schedule reporting. The Contractor shall adhere to the approved schedule of construction. The schedule of construction shall not be altered without the written approval of the Contracting Officer. In the event of changes in the schedule of construction, under applicable provisions of the contract, the Contractor shall resubmit to the Contracting Officer the schedule of construction reflecting such changes.

Questions, concerns, and information pertaining to the project shall be submitted to the Contracting Officer on Form 253, Request for Information, Attachment 2 to this section.

1.8.2 Monthly Progress Schedules and Monthly Technical Progress Narratives

The Contractor shall submit to the Contracting Officer the following reports covering work accomplished each month of contract performance. The technical progress narrative and the monthly progress schedule, on Form LF-107, (Attachment 1), shall be prepared covering a period from the tenth of one month through the ninth of the following month and shall be submitted so as to be received no later than the 15th of the month in which the reporting period ends. The Contractor shall certify the accuracy of monthly reports being submitted by signing the technical progress narrative and block 4 of Form LF-107.

1.8.2.1 Monthly Progress Schedules

The Contractor shall prepare monthly progress schedules, on Form LF-107, in accordance with the instructions on the reverse side of the form and shall show both the NASA approved schedule and the Contractor's current working schedule.

1.8.2.2 Monthly Technical Progress Narratives

Monthly technical progress narratives shall be brief, factual, and informal and shall be prepared in accordance with the following format:

A cover page containing:

Contract number and title.

Period of performance being reported.

Contractor's name and signature.

Date of publication.

Summary outlook - A short statement summarizing the current time status in relation to plan as well as the outlook for achieving major goals.

Status versus plans.

Significant progress - A description of overall progress plus a separate description for each reporting category on the Form LF-107 on which effort was expended during the reporting period.

Problem areas - A description of current problems and their schedule and resource implication which may impede performance.

Corrective actions - A description of corrective action which has been taken or which is planned to correct any existing problem.

Plans - A description of work to be performed during the next reporting period.

Recommendations - Recommendations for action on the part of Langley Research Center.

1.9 AS-BUILT CONTRACT DRAWINGS

The Contractor shall maintain a red-lined set of contract construction drawings that reflect current "As-Built" conditions in accordance with specification Section 01330, SD-04 Drawings, "As-Built Contract Drawings."

1.10 OPERATION AND MAINTENANCE (O&M) MANUAL

The Contractor shall submit to the Contracting Officer for approval the Operation and Maintenance (O&M) Manuals for the equipment specified under the various headings of these specifications. These submittals shall be complete and detailed.

1.11 PRICE BREAKDOWN FOR DETERMINING PROGRESS PAYMENTS

The Contractor shall submit a price breakdown if it intends to request progress payments. Where several items are involved, each shall be shown separately. This breakdown shall be prepared using the items, major parts, and components which were approved by the Contracting Officer for the schedule of construction, as required above, to provide a schedule/price correlation for use in the assessment of progress payments, and shall separate equipment and material prices from labor prices for each portion of the work. No progress payments will be made until the price breakdown as submitted has been approved by the Contracting Officer.

1.12 PRICE BREAKDOWN FOR MODIFICATION PROPOSALS

The Contractor shall furnish an itemized price breakdown within 14 calendar days of receipt of a Government change order or request for proposal. Unless otherwise directed, the breakdown shall be in sufficient detail to

permit an analysis of all material, labor, equipment, subcontract and overhead costs as well as profit, and shall cover all work involved to accomplish the modification whether deleted, added, or changed. Subcontractor costs shall also be supported by similarly detailed price breakdown. If the proposal includes a requested time extension, a detailed justification shall also be furnished. The Attachment 3, Estimate for Contract Modification Change Item forms shall be used to furnish this price breakdown.

1.13 MINIMUM EMPLOYEE COMPENSATION

The U.S. Department of Labor Wage Determination, Enclosure 4 of the Solicitation, establishes the minimum compensation levels for laborers and mechanics employed on site at the Langley Research Center.

Certified payrolls for on-site work of the prime Contractor and all subcontractors shall be submitted weekly as required by Section 01330.

1.14 CONTRACTOR RELEASE FORM

The Contractor shall execute and submit a Contractor Release Form, NASA Form 778, at contract completion.

1.15 BULLETIN BOARD

Immediately upon beginning site work, the Contractor shall provide at the job site a weatherproof bulletin board for displaying the fair employment poster, wage rates, and safety bulletins and posters. The bulletin board shall be located in a conspicuous place, easily accessible to all employees. Legible copies of the aforementioned data shall be displayed until on-site work is complete.

1.16 ORDER STATUS REPORTS

Upon request of the Contracting Officer, the Contractor shall promptly submit reports showing the status of any orders or subcontracts which may delay or are delaying the overall contract schedule. Order status reports shall include:

Contract or order number, date submitted to the supplier, date accepted by the supplier, supplier's name and address.

Delivery date needed to meet contract schedule.

Delivery date agreed to by the supplier, and any subsequent changes in that date.

Reasons for changes in delivery dates.

Effect which the latest promised delivery date will have on the contract schedule.

A summary of the Contractor's efforts to bring the promised delivery date in line with the requirements of the contract schedule, including

efforts made to place the order or subcontract with other suppliers.

1.17 MATERIALS AND EQUIPMENT

Materials and equipment provided by the Contractor shall be standard catalog products of manufacturers regularly engaged in the manufacture of the products unless otherwise specified herein.

Materials and equipment shall meet the requirements of the contract and shall be suitable for the specified installation. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. Materials and equipment shall be new and free from defects.

Where equipment specified by designations of the manufacturer requires modification to fully meet contract requirements, such modification shall be made by the Contractor without additional cost to the Government.

Where two or more types of equipment or materials are specified without indication of preference, it shall be optional with the Contractor which one is used; but the same type shall be used throughout.

Where equipment or materials are specified by the designations of the manufacturer, "or equal", the Contractor, if it elects to furnish other than the brand name product, is responsible for any necessary redesign, relocation and rework of associated construction, at any time during the course of the contract. The proposed materials or equipment substitution with any required redesign, relocation, or rework data shall be submitted for approval of the Contracting Officer.

All equipment and material data, including location, function, and characteristics shall be furnished to the Contracting Officer for approval as specified in the following sections. Machinery, equipment, materials, and articles furnished without such approval shall be at the risk of subsequent rejection, and will not be considered in computing progress payments.

1.18 MATERIAL AND EQUIPMENT INSTALLATION

The Contractor shall install material and equipment in accordance with the requirements of the contract drawings and Government approved recommendations of the manufacturers. Degradation of the designated fire ratings of walls, partitions, ceilings, and floors by the installation shall not be permitted.

1.19 HANDLING/PROTECTION OF CONTRACTOR MATERIAL AND EQUIPMENT

All shipments shall be addressed to the Contractor and the Contractor shall be responsible for their receipt, unloading, handling, and storage at the site. The Government will not accept deliveries on behalf of the Contractor or its subcontractors, nor assume any responsibility for security of materials, equipment or supplies delivered to the site.

The Contractor shall at all times protect and preserve all contractually

required materials, supplies and equipment of every description (including property which may be Government-furnished or owned) and all work performed. If, as determined by the Contracting Officer, material, equipment, supplies and work performed are not adequately protected by the Contractor, such property may be protected by the Government and the cost thereof will be charged to the Contractor.

When Government-owned equipment is to be utilized by the Contractor at the construction site, the Contractor shall jointly inventory such equipment with the assigned Inspector, mutually agreeing as to condition and quantities. Upon completion of the inventory, the Contractor shall accept the equipment and give the Government a signed receipt. The Contractor shall be responsible for the equipment, its protection from damage, and availability for installation. Even in the absence of such a joint inventory, the Contractor assumes full responsibility for such Government-owned equipment when it comes into its possession. The Contractor shall submit a record of existing conditions prior to use of Government-owned equipment.

1.20 ON-SITE CLEAN-UP AND DISPOSAL OF MATERIALS

If the operations of the Contractor result in deposition of dirt or other debris on any area, it shall clean such facilities at such intervals and in such manner to prevent the formation of undesirable quantities of mud or dust, and avoid making any other nuisance.

The Contractor shall not dispose of materials of hazardous or environmentally damaging nature into the storm or sanitary sewer systems. The Contractor shall be responsible for proper handling and disposal of hazardous wastes generated by its activities in accordance with applicable federal, state and local regulations. See Section 01060, "Langley Safety and Environmental Requirements", for additional hazardous waste disposal requirements.

Scrap materials removed and not specified for reuse or for return to the Government shall become the property of the Contractor and shall be removed from the Government premises and properly dispositioned.

All excess soil excavated from the project site shall become the property of the Contractor. The Contractor shall remove and dispose of all excess soil from the confines of Langley Research Center at a permitted landfill. The Contractor shall notify the Contracting Officer, in writing a minimum of ten calendar days prior to scheduling the removal and disposal of excavated soils. The Contractor's notification shall include the name, address, and permit number of the intended disposal site, a written description of the soil type, and an estimated quantity of soil to be disposed. The Contracting Officer will provide testing of the soil materials and notify the Contractor, in writing, of test results with approval of disposal or specific direction on special disposal requirements. The Contractor shall be required to stockpile excavated materials until testing results are received. At no time shall the contractor remove soil materials without prior approval by the Contracting Officer. The Contractor is responsible for ensuring that removal and disposal of excavated soils complies with all applicable Federal, State,

and local environmental laws and regulations. The Contractor shall be responsible for all disposal related permits and fees.

When construction work is performed in Government facilities and the Government continues to use these areas, the Contractor shall keep floors and platforms swept clean or vacuumed daily of any debris created by its work. Debris shall be stored in closed metal containers and shall be removed from these areas at least weekly.

In other construction areas, the Contractor shall collect and store all waste material, scrap lumber and rubbish in piles or containers. This material shall be removed weekly from the site or more often if the material constitutes a fire hazard.

The Contractor shall clean application equipment promptly and thoroughly with a suitable solvent after each use and store the solvent in a clean, covered, well-ventilated container.

At the end of each working day, the Contractor shall collect and remove paint materials, rubbish, rags and other similar materials shall be collected and removed from the project area.

At the completion of the work, the Contractor shall remove all paint spots from finished surfaces and leave the project in a clean condition.

1.21 UTILITY OUTAGES AND POWER CONNECTIONS

1.21.1 Utility Outages

Work shall be scheduled to hold outages to a minimum.

Utility outages required during the prosecution of work that affect existing systems shall be scheduled at the convenience of the Government. Any interruption of utilities or services that would interfere with the operation of a facility will be permitted only on week-ends between the hours of 12:00 midnight Friday and 10:00 p.m. on the following Sunday. The Contracting Officer may permit interruptions at other times. Any utilities or service connections made at other than normal working hours shall be at no additional cost to the Government. Permission to make such an interruption shall be requested in writing to the Contracting Officer at least seven calendar days prior to the day of interruption.

The Contractor shall schedule all work necessitating power shutdowns or outages shall be scheduled with the Contracting Officer by submitting a written request for utility outage stating the date and time the desired interruption will commence, the anticipated period of interruption, and feeders and circuits to be interrupted. No interruption shall be made without authorization from the Contracting Officer. If a scheduled power interruption is to extend into the regular working hours, the Contractor shall notify the Contracting Officer 24 hours in advance.

1.21.2 Application for Connecting to Government Electrical Utilities

Prior to making connection to any part of the Government's electrical power

distribution system, the Contractor shall make application to the Contracting Officer stating the date, time, location, and the service required. The Contractor shall also state when such connection is desired.

Before granting the Contractor permission for such connection, the Government will make the necessary checks of the Contractor's system to assure its adequacy and safety and that the Government's supply is adequate at that point for such connection.

The Contractor shall perform the initial energizing of all new electrical equipment in the presence of an authorized representative of the Contracting Officer.

Prior to connecting into any existing Government electrical utility, the Contractor shall conform to the requirements of Section 01060, Langley Safety and Environmental Requirements.

1.22 USE OF GOVERNMENT PREMISES

The Contractor shall submit to the Contracting Officer a record of existing conditions detailing damaged Government property as agreed upon with the Government Representative.

1.22.1 Boundaries and Site Requirements

Boundary lines on drawings are for delineation of the general working area. Such lines do not relieve the Contractor of its responsibility for completing construction features, utility runs or tie-ins which cross or extend beyond such limit lines as provided by specifications or drawings requirements. The site will be made available "as is", and unless otherwise specified, the Contractor shall be responsible for clearing the site area, roads, utilities, and other off-site areas of all obstructions, both natural and manmade, which would interfere with the performance of the work.

1.22.2 Adjacent Premises and Existing Services

Government premises adjacent to the construction will be made available for use by the Contractor, without cost, whenever such use will not interfere with other Government uses or purposes. The Contractor shall promptly vacate such premises if ordered to do so by the Contracting Officer. When the contract work is to be connected to existing buildings or other construction, the Contractor shall do such repairs and cleanup as may be necessary to leave the completed work in a neat and orderly condition.

Existing services shall be maintained without interruptions, or, if interrupted by the operations of the Contractor, shall be promptly restored. The Contractor shall establish and maintain adequate drainage, from the beginning of construction, in the prescribed work areas, and shall avoid making drainage problems in adjacent or other work areas. The Contractor may block existing roads and sidewalks only by permission of the Contracting Officer obtained two calendar days in advance. The Contractor shall provide a temporary by-pass during such operations, unless otherwise directed.

1.22.3 Vehicle Weight Limits

Roads at the Langley Research Center are limited to axle loads of less than 32,000 pounds. The Contractor shall not exceed these limits. When it is necessary to cross curbing or sidewalks, the Contractor shall construct secure bridges across them, and at the completion of all work, such bridges shall be removed.

1.23 BARRICADES AND TRAFFIC CONTROL

The Contractor shall conduct all work to minimize obstruction of traffic, and traffic shall be maintained on at least one half of the roadway width at all times. Approval of the Contracting Officer shall be obtained before starting any activity that will obstruct traffic. Barricades and traffic control devices shall comply with Section 01060, Signs, Signals and Barricades.

1.24 ON-SITE UTILITIES

1.24.1 Water

Water will be furnished by the Government without charge. The Contractor shall make all necessary connections to the existing water mains, shall furnish all equipment and shall run the water lines required, connecting at points and following routes approved by the Contracting Officer. Lines shall be installed and maintained in a sanitary and watertight manner, and shall be removed and capped at the completion of the contract. Water will be made available within 150 feet of the job site.

1.24.2 Electrical Power

The Government will furnish electric power for general construction purposes, with a maximum demand of 25 kilowatts, without cost to the Contractor. This electrical energy will be made available to the Contractor, and at the option of the Contracting Officer, will be supplied at three-phase, four-wire, 60 cycles, 120/208 volts. This electrical energy is provided for lighting, motor-driven construction equipment, heaters and humidity control of equipment and machinery, and general construction purposes only.

1.24.3 Telephone Service

The Government charges a fee for providing an on-site circuit to the Contractor. This fee at the Contractor's option may be charged directly to the Contractor or may be a deduction from the contract value. The Contractor is responsible for making arrangements with the local phone company for phone service. The Contractor shall contact the Contracting Officer's Technical Representative for guidance in having an on-site circuit installed.

1.25 ON-SITE WATER CONTAMINATION

The Contractor shall not pollute streams, lakes, beaches, waterways, or

reservoirs. Refuse, fuels, oils, bitumens, calcium chloride, acids, and toxic materials shall be disposed of in a manner to prevent their entry into the water. The Contractor shall comply with applicable federal, state, and municipal laws concerning pollution of rivers and streams. Work under this contract shall be performed in such a manner that objectionable conditions will not be created on or adjacent to project site areas.

1.26 ON-SITE GOVERNMENT/CONTRACTOR/SUBCONTRACTOR COORDINATION

The existing facility will be occupied by the Government during construction. The Contractor shall coordinate its work with the Contracting Officer to ensure minimum interference with Government activities during construction.

Other Contractors will be working at the site of the work during the performance of this contract. The Government will be responsible for the coordination of work between on-site prime Contractors.

The Contractor shall be responsible for familiarizing each of its subcontractors with all requirements (this includes administrative as well as technical) of the contract affecting each subcontractor, respectively. The Contractor shall be responsible for coordinating the work of its subcontractors or suppliers to prevent any interference or omission whatsoever. The divisions or sections of the specifications shall not be interpreted as limiting or defining the work for purposes of dividing the work among subcontractors, or to limit the work performed by any trade.

The Contractor shall be responsible to the Government for acts and omissions of its own employees and of subcontractors and their employees. The Contracting Officer will not undertake to settle any differences between the Contractor and its subcontractors, or between subcontractors. All business pertaining to the contract shall be conducted through the Contractor. If the Contractor specifically authorizes in writing a subcontractor to act as its agent, it shall state the specific authority conferred. The Contractor shall also be bound by any agreement made between the agent acting within the scope of its authority and the Government.

The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their work. The Contractor shall conduct its work so as not to impede or interfere with the work of such other Contractors or persons engaged in or about the site. Whenever any work performed by the Contractor adjoins or affects any work by any other Contractor, the Contracting Officer will decide any disputes between the Contractor and such other Contractor. The Contracting Officer's decision, in writing, shall be final and conclusive upon both parties.

If the Contractor causes damage to the work or property of any other Contractor on the project, the Contractor shall, upon due notice, repair such damage or pay for such repair as directed by the Contracting Officer. If such other Contractor sues the Government on account of any damage alleged to have been so sustained, the Government will notify this Contractor who shall defend such proceeding, and if any judgment or award

against the Government arises therefrom, this Contractor shall indemnify it and shall reimburse the Government for all attorneys' fees and court costs which the Government has incurred.

The Contractor shall not endanger any work of any other Contractors by cutting, excavating or otherwise altering any work of any other Contractor, except with the written consent of the Contracting Officer.

If a dispute arises between the various on-site Contractors as to their responsibility for cleaning up as required, the Government may clean up and charge the cost thereof to the several Contractors as the Contracting Officer shall determine to be just.

1.27 SANITARY CONVENIENCES

The Contractor shall provide and maintain all necessary sanitary conveniences for use of its employees, as directed by the Contracting Officer. The criteria for determining the adequacy of such facilities provided shall be as stated in the Department of Labor, Safety and Health Regulations, as amended. These facilities shall be kept clean and their use shall be strictly enforced.

1.28 PLUMBING WORKERS' QUALIFICATIONS

All plumbing work shall be performed by plumbing tradesmen who have in their possession a current Apprentice, Journeyman, or Master's plumbing license card, as issued by the Commonwealth of Virginia. When plumbing tradesmen do not have such a Virginia card or license, the Contractor shall submit to the Contracting Officer for approval evidence that such tradesmen have equivalent permits issued by other Governmental jurisdictions. Such equivalency submittal shall include documentation defining the criteria required for licensing by the involved jurisdiction, so that the Contracting Officer can determine that valid equivalency exists.

1.29 ELECTRICAL WORKERS' QUALIFICATIONS

All electrical work shall be performed by electrical tradesmen who have in their possession a current Apprentice, Journeyman, or Master's Electrical License Card, as issued by the Commonwealth of Virginia. When electrical tradesmen do not have such a Virginia license, the Contractor shall submit to the Contracting Officer for approval, evidence that such tradesmen have equivalent permits issued by other Governmental jurisdictions. Such equivalency submittals shall include documentation defining the criteria required for licensing by the involved jurisdiction, so that the Contracting Officer can determine that valid equivalency exists.

1.30 MECHANICAL WORKERS' QUALIFICATIONS

All mechanical work shall be performed by mechanical tradesmen who have in their possession a current Apprentice, Journeyman, or Master's mechanical license card, as issued by the Commonwealth of Virginia. When mechanical tradesmen do not have such a Virginia card or license, the Contractor shall submit to the Contracting Officer for approval, evidence that such tradesmen have equivalent permits issued by other Governmental

jurisdictions. Such equivalency submittal shall include documentation defining the criteria required for licensing by the involved jurisdiction, so that the Contracting Officer can determine that valid equivalency exists.

1.31 INSPECTION RECORDS

In accordance with FAR Clause 52.246-12, "Inspection of Construction", (August 1996), the Contractor shall maintain daily inspection records and make them available to the Contracting Officer. Attachment 4, Daily Construction Report, shall be used to maintain the required inspection records.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Langley Research Center Hampton, Virginia 23681-2199										CONTRACT PROGRESS SCHEDULE REPORT										1. REPORTING FOR MONTH ENDING								
2. CONTRACT TITLE:		3. CONTRACTOR (Name and Address)															5. CONTRACT NO.					LATEST MOD. NO.						
		4. APPROVED (Contractor's Project Manager)															Date					6. NASA APPROVED DATE						
7. REPORTING CATEGORY		8. SCHEDULE PROGRESS																									9. TECH OBJECTIVE % COMPLETE	

NASA APPROVED BASELINE SCHEDULE

CONTRACTOR'S CURRENT OPERATING SCHEDULE

INSTRUCTIONS FOR COMPLETING OF THE CONTRACT PROGRESS SCHEDULE REPORT
(Previously NASA C-63)

Obtain forms from the NASA-Langley Research Center Contracting Officer.

Refer to the submittal instructions in the contract Statement of Work (SOW) _____ for space and flight projects, and sections 01011 and 01330 for facilities projects.

Block Entries

1. The ending date of the accounting month being reported.
2. The contract title as shown on the cover page of the contract.
3. The full name and address of the contractor (if a division of the contractor is performing the work, use the division name and address).
4. Contractor's Project Manager's signature and date approved.
5. The complete NASA contract number and latest modification number.
6. The date the NASA Project Manager for space and flight projects/Contracting Officer's Technical Representative (COTR), for facilities projects approved the original baseline schedule. If the original baseline schedule is revised, ONLY USE the date the NASA Project Manager/COTR approves the revision.
7. The WBS reporting categories agreed to in the current negotiated contract. (See SOW _____ or section 01011.)
8. The attached chart shall be used to show the schedules and status of the Work Breakdown Structure (WBS) reporting categories.

Top line: The calendar years.

Second line: The first letter of each month starting with the month of the contract award.

Time-now indicator: Make a vertical broken line to indicate the end of the reporting month.

Shaded blocks: Use open triangles to indicate the start and completion milestones. This line shall show the current NASA-approved schedule for each WBS reporting category.

Unshaded blocks: Use an open schedule bar to indicate the time span of the Contractor's current operating schedule. Place an open triangle at the end of the open bar to represent the completion milestones. The contractor's current operating schedule may be the same as, or different from the current NASA-approved baseline schedule.

To show schedule status to time-now, determine the length of time allocated in the baseline schedule for the technical achievement to date. Then blacken the schedule bar to the time point in the baseline schedule that represents this technical achievement to date. Blacken the completion triangle at the point in time each milestone is actually achieved. Consider any modifications made in the current working schedule. NOTE: The percent-ratio of the blackened portion of the schedule bar to its total schedule is not necessarily the same as the percent completion of the technical objective. The percent of manhours or dollars used to date is not a measure of schedule progress for end-item WBS categories.

Use arrows (< >) to indicate a break in scheduled activity.

Place a number (1,2,3, etc.) within a triangle to indicate number of times officially rescheduled. The baseline triangles are a permanent part of the schedules. After displaying the prior milestone triangle for 1 month, it should be deleted (leaving only the current re-scheduled triangle).

9. Evaluate the progress toward meeting the technical objective of each reporting category. Enter an estimated percentage that indicates the progress toward the technical objective actually achieved as of the Report for Month Ending date.

Consider all aspects of progress: technical specifications met, quality, production of hardware, software achievement, etc. Subjective factors, such as complexity of tasks, state-of-the-art, and level of confidence that the objective can be achieved, should be considered. Use actual costs or manhours to date as a guide to determine technical achievement ONLY if there is a direct correlation.

PROJECT TITLE: _____

MODIFICATION DESCRIPTION: _____

PRIME CONTRACTOR'S WORK**Revisions/Comments**

1. Direct Materials				
2. Sales Tax on Materials	4.50 % of line 1	4.50 %		
3. Direct Labor (including fringe benefits)				
*4. Insurance & Taxes	_____ % of line 3	%		
5. Rental Equipment				
6. Sales Tax on Rental Equipment	4.50 % of line 5	4.50 %		
7. Equipment Ownership and Operating Expenses				
8. SUBTOTAL (Add lines 1–7)				
9. Overhead (Field + Home Office)	_____ % of line 8	%		
10. SUBTOTAL (Add lines 8 and 9)				
11. Prime Profit	_____ % of line 10	%		
12. SUBTOTAL (Add lines 10 and 11)				

Prime Remarks: _____

SUBCONTRACTOR'S WORK**Revisions/Comments**

13. Direct Materials				
14. Sales Tax on Materials	4.50 % of line 13	4.50 %		
15. Direct Labor (including fringe benefits)				
*16. Insurance & Taxes	_____ % of line 15	%		
17. Rental Equipment				
18. Sales Tax on Rental Equipment	4.50 % of line 17	4.50 %		
19. Equipment Ownership and Operating Expenses				
20. SUBTOTAL (Add lines 13-19)				
21. Overhead (Field + Home Office)	_____ % of line 20	%		
22. SUBTOTAL (Add lines 20 and 21)				
23. Profit	_____ % of line 22	%		
24. SUBTOTAL (Add lines 22 and 23)				

Sub's Remarks: _____

SUMMARY**Revisions/Comments**

25. Prime Contractor's Work (from line 12)				
26. Subcontractor's Work (from line 24)				
27. Prime's Commission on Subcontractor Work	_____ % of line 20	%		
28. SUBTOTAL (add lines 25, 26, and 27)				
29. Prime Contractor's Bond	_____ % of line 28	%		
30. TOTAL COST (Add lines 28 and 29)				

Estimated time extension and justification _____

Prime Contractor Name: _____

Subcontractor Name: _____

Signature of Preparer _____

Title of Preparer _____

*THIS ITEM MAY ONLY INCLUDE LABOR BURDEN FOR FICA, FUTA, SUTA, AND WORKER'S COMP.

BREAKDOWN OF DIRECT COSTS

DATE _____

Work Items Prime Contractor	QTY	UNIT	MATERIAL COST		LABOR COST		O = Owned R = Rental	EQUIPMENT			
			Per Unit	Total	Per Unit	Total		Qty	Rate	Owned	Rental
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											
17.											
18.											
19.											
20.											
DIRECT Prime Contractor's TOTAL											
				Mat/Cost Total		Labor/Cost Total				Owned Total	Rental Total

Work Items Subcontractor	QTY	UNIT	MATERIAL COST		LABOR COST		O = Owned R = Rental	EQUIPMENT			
			Per Unit	Total	Per Unit	Total		Qty	Rate	Owned	Rental
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											
17.											
18.											
19.											
20.											
DIRECT Subcontractor's TOTAL											
				Mat/Cost Total		Labor/Cost Total				Owned Total	Rental Total

Daily Construction Report					Date
Contract No.			Title and Location		
Contractor				Superintendent or Foreman	
Weather		Temperature °F			
Weather Affects Delay Critical Path Activity <input type="checkbox"/> Yes <input type="checkbox"/> No					
Prime Contractor/Subcontractor Workforce <i>(if space provided below is inadequate, use additional sheets)</i>				Location and Description Of Work Performed	
No.	Trade	Hours	Employer		
Total Work Hours on Job Site This Date				Were there any lost time accidents this date? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, a copy of the completed NASA Form 95 is required.	
Material Received and Equipment On-Site (<i>w/value > \$10,000</i>)					
Test Performed (<i>give brief description of test performed</i>)					

Remarks (<i>Include directions received from CO/COTR, Safety; compliance notices received; pertinent information.</i>)		
<input type="checkbox"/> Check if continued on other side <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div>_____ Contractor/Superintendent</div> <div>_____ Date</div> </div>		
Inspector's Remarks and/or exceptions to this report		
<input type="checkbox"/> Check if continued on other side <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div>_____ Inspector</div> <div>_____ Date</div> </div>		

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01060

LANGLEY SAFETY AND ENVIRONMENTAL REQUIREMENTS

PART 1 GENERAL

- 1.1 SUMMARY
- 1.2 REFERENCES
- 1.3 SUBMITTALS
- 1.4 GENERAL SAFETY REQUIREMENTS
 - 1.4.1 Safety Plan
 - 1.4.2 Recordkeeping
 - 1.4.3 Safety Briefing
 - 1.4.4 Inspections
 - 1.4.5 Housekeeping
 - 1.4.6 Illumination
 - 1.4.7 Ladders
 - 1.4.8 Motor Vehicles and Mechanized Equipment
 - 1.4.9 Hazardous Materials
- 1.5 SAFETY CLEARANCE PROCEDURES/LOCKOUT/TAGOUT
- 1.6 ELECTRICAL SAFETY
 - 1.6.1 General Electrical Safety Requirements
 - 1.6.2 Special Electrical Safety Requirements
 - 1.6.2.1 Electrical Safety Workers' Qualifications and Duties
 - 1.6.2.2 Equipment Safety Tests and Checks
 - 1.6.2.3 Protective System Checks
 - 1.6.2.4 High Voltage Insulation Testing of Electrical Equipment
 - 1.6.2.5 Rules Governing Contractor Connection Into Government Electrical Utilitiess
 - 1.6.2.6 Switching
 - 1.6.2.7 Removal of Electrical Equipment and/or Wiring
 - 1.6.2.8 Energized Substations (2300 Volts and Above)
 - 1.6.3 Protective Grounding
 - 1.6.3.1 Definition and Requirements
 - 1.6.3.2 Responsibility
 - 1.6.3.3 Method of Application and Removal
 - 1.6.3.4 Underground Cables
 - 1.6.4 Underground Electrical
 - 1.6.4.1 General
 - 1.6.4.2 Energized Cables in Manholes
 - 1.6.4.3 Cutting and Splicing Power Cables
- 1.7 PRESSURE VESSELS
- 1.8 DEMOLITION OPERATIONS
- 1.9 FIRE PREVENTION AND PROTECTION
 - 1.9.1 General Requirements

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

- 1.9.2 Welding, Flame Cutting and Melting
- 1.9.3 Prohibitions
- 1.9.4 Safeguards
- 1.9.5 Firewatch
- 1.9.6 Means of Egress
- 1.9.7 Fire Protection and Detection Systems
- 1.9.8 Portable Fire Extinguishers
- 1.9.9 Temporary Heaters
- 1.9.10 Removal of Combustible Waste Material
- 1.9.11 Disposal of Rubbish
- 1.9.12 Flammable and Combustible Liquids
- 1.9.13 Smoking
- 1.9.14 Non-Emergency Use of Fire Hydrants
- 1.9.15 Fire Department Access
- 1.10 ASBESTOS OPERATIONS
 - 1.10.1 General Requirements
 - 1.10.2 Notification Requirements
 - 1.10.3 Operational Procedure
 - 1.10.4 Additional Requirements for Removal of Friable Asbestos
 - 1.10.5 Disposal of Asbestos Waste
 - 1.10.6 Submittals
 - 1.10.7 Monitoring Requirements
 - 1.10.7.1 Licensed Asbestos Project Monitor
 - 1.10.7.2 Duties of the Project Monitor
 - 1.10.7.3 Air Sampling
 - 1.10.8 Final Clearance
- 1.11 USE OF EXPLOSIVES
- 1.12 FALL PROTECTION (OSHA 29 CFR PART 1926.500 THROUGH 1926.503)
- 1.13 LIFTING OPERATIONS
 - 1.13.1 General
 - 1.13.2 Lifting Devices
 - 1.13.3 Guidelines for Proper Use of A-Frame Type Lifting Devices
 - 1.13.4 Certification of Qualified Operators of Government Owned Lifting Equipmentt
- 1.14 ACCIDENTS AND SAFETY RELATED INCIDENTS
 - 1.14.1 Emergency Response and First Aid Facilities
 - 1.14.2 Accident Reporting
- 1.15 DISPOSAL OF HAZARDOUS WASTE MATERIAL
- 1.16 PERSONAL PROTECTIVE EQUIPMENT
- 1.17 SIGNS, SIGNALS AND BARRICADES
 - 1.17.1 Accident Prevention Signs
 - 1.17.2 Signaling
 - 1.17.3 Barricades
- 1.18 HAND AND POWER TOOLS
- 1.19 SCAFFOLDING

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

-- End of Section Table of Contents --

SECTION 01060

LANGLEY SAFETY AND ENVIRONMENTAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO D-MUTCD-3 (2001) Manual for Uniform Control of
Traffic Devices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 1368 (2002) Standard for Visual Inspection
Following Asbestos Abatement Projects

ANSI/ASTM F 496 (2002) Standard Specification for the
In-Service Care of Insulating Gloves and
Sleeves

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.1 (2000) Safety Requirements for Ladders -
Portable Wood

ANSI A14.2 (2000) Safety Requirements for Portable
Metal Ladders

ANSI A14.5 (2000) Safety Requirements for Fiberglass
Ladders

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B15.1 (2000) Safety Standard for Mechanical
Power Transmission

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR Part 1904 Recording and Reporting Occupational

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Injuries and Illnesses

29 CFR Part 1910	Occupational Safety and Health Standards
29 CFR Part 1926	Safety and Health Regulations for Construction
40 CFR Part 61	National Emissions Standards for Hazardous Air Pollutants
40 CFR Part 763	Aggressive Sampling Techniques
40 CFR Part 173.1090	Department of Transportation Regulations

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 95	(2002) Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage
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LANGLEY RESEARCH CENTER (LaRC)

LAPD 1700.7	(March 2001) Traffic Management
LAPG 1710.10	(August 2002) Safety Clearance Procedures (Lockout/Tagout)
LAPG 1710.40	(June 2003) Safety Regulations Covering Pressurized Systems
LAPG 1740.2	(July 1999) Facility Safety Requirements
LAPG 1740.6	(May 2001) Personnel Safety Certification
LAPG 8800.1	(September 2002) Environmental Program Manual

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-STD-8719.11	(2000) NASA Safety Standard for Fire Protection
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2002) Standard for Portable Fire Extinguishers
NFPA 30	(2000) Flammable and Combustible Liquids Code
NFPA 31	(2001) Standard for the Installation of Oil-Burning Equipment
NFPA 51	(2002) Standard for the Design and

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

	Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes
NFPA 51B	(1999) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
NFPA 54	(2002) National Fuel Gas Code
NFPA 58	(2001) Standard for Liquefied Petroleum Gas
NFPA 70	(2002) National Electrical Code
NFPA 101	(2003) Life Safety Code
NFPA 211	(2000) Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances

VIRGINIA ADMINISTRATIVE CODE (VAC)

9 VAC-20-60	Virginia Hazardous Air Pollutants
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1.3 SUBMITTALS

The Contractor shall submit to the Contracting Officer in accordance with the requirements of Section 01330, "Submittals" the following:

SD-08 Statements

Safety Plan

Application for Work on Energized Electrical Circuits Below 600
Volts

Electrical Safety Workers' Qualifications

Application for Making Connection to Government Electrical
Utilities

Energized Substations Work Plan

Power Outage Request

Asbestos Handling License (State and Federal)

Proof of Notification of Proposed Asbestos Work to Virginia and EPA

Asbestos Operational Procedure

Certified Statement for Off-Site Transportation of Asbestos
Products for Disposal

Signed Manifest to Document Receipt of Asbestos

List of Riggers

Sewer Disposal Permit

1.4 GENERAL SAFETY REQUIREMENTS

1.4.1 Safety Plan

On-site work shall not commence prior to the Contracting Officer's approval of the Safety Plan.

The Contractor safety plan is a written plan prepared by the Contractor summarizing the overall safety program that will cover the employees and equipment used to fulfill the contract. The safety plan should address all aspects of the contract performance to include manufacturing, construction, transportation, and testing. It is not intended that the Contractor's normal industrial home-plant safety rules and directives be subject to NASA approval. However, it is intended to ensure that the Contractor has an adequate safety program for on-site work. Attachment 1, Safety Program Guide, to this section provides a list of items required to be addressed in the safety plan; however, special safety procedures may be required, depending on the scope of work, environmental conditions or area of operation.

The safety plan shall contain a brief summary and scope of the work to be performed.

The Contractor's safety representative, responsible for ensuring compliance with all applicable rules and regulations, shall be identified in the safety plan.

1.4.2 Recordkeeping

The Contractor shall have a log and summary of all recordable occupational injuries and illnesses for their company, on an OSHA 300, "Log of Work-Related Injuries and Illnesses," and OSHA 300A, "Summary of Work-Related Injuries and Illnesses," or their equivalent at a central place. The on-site Contractor shall have the address and telephone number of the central place where the OSHA 300 and 300A logs are maintained and shall have personnel available at the central place during normal business hours to provide information from the records maintained there, by telephone or mail. (OSHA 29 CFR Part 1904)

1.4.3 Safety Briefing

The Contractor's on-site Superintendent, as well as a subcontractor representative from each on-site subcontractor supporting the effort, shall attend a Safety Briefing at the Safety and Facility Assurance Office, Building 1162, Room 122, Langley Research Center (LaRC), prior to any on-site activity. Briefing time is 7:30 a.m., Monday, Wednesday and Friday. This effort will be coordinated with the required badging activity. The prime contractor shall provide a list of all prime and subcontracted personnel to the LaRC Badge and Pass Office to acquire badges.

1.4.4 Inspections

In accordance with Section 107 of the Contract Work Hours and Safety Standards Act, a representative of the NASA Langley Research Center shall have the right of entry to any on-site area of contract performance to ensure compliance with all applicable rules and regulations. (OSHA 29 CFR Part 1926.3)

Any condition that threatens the safety or security of (1) personnel (2) Government property or equipment, or (3) information, or any conditions that affect LaRC's environmental compliance may be subject to immediate work stoppage by the Contracting Officer (CO), the Contracting Officer's Technical Representative (COTR), or the CO's designated inspection representative, and shall not resume until directed by the Contracting Officer.

1.4.5 Housekeeping

During the course of construction, alteration, or repairs the Contractor shall keep form and scrap lumber with protruding nails, and all other debris cleared from work areas, passageways, and stairs, in and around buildings or other structures.

1.4.6 Illumination

The Contractor shall light construction areas, aisles, stairs, ramps, runways, corridors, offices, shops, and storage areas where work is in progress with either natural or artificial illumination. (OSHA 29 CFR Part 1926.26)

1.4.7 Ladders

All ladders shall comply with ANSI A14: wood ladders (ANSI A14.1), metal ladders (ANSI A14.2), and fiberglass ladders (ANSI A14.5).

1.4.8 Motor Vehicles and Mechanized Equipment

All contractor-owned vehicles shall abide by LaRC traffic regulations in accordance with LAPD 1700.7, "Traffic Management," and OSHA regulations in accordance with OSHA 29 CFR Part 1926.600 through 1926.606.

1.4.9 Hazardous Materials

In accordance with OSHA 29 CFR Part 1910.1200, the Contractor shall have a hazardous communications program, when applicable, available for each chemical, oil, lubricant, or solvent used on the job-site. A Material Safety Data Sheet (MSDS) shall be available for each chemical used on the job-site.

1.5 SAFETY CLEARANCE PROCEDURES/LOCKOUT/TAGOUT

All contractors performing work at Langley Research Center (LaRC) shall comply with the safety clearance procedures described in LAPG 1710.10, "Safety Clearance Procedures (Lockout/Tagout)." Failure to comply with

LAPG 1710.10 will result in the exclusion of the individual responsible for violating LAPG 1710.10 from LaRC. The LaRC Lockout/Tagout procedures involve the use of red tags, red locks, associated locking hardware, LaRC issued personal locks, and LaRC issued lock boxes.

Lockout/Tagout Overview

(Terminology: "Protected Person" refers to any person who after placing a personal lock on the lockout/tagout where required becomes protected by a lockout/tagout; "Responsible Person" refers to a person who has lockout/tagout responsibility for a group of protected persons; and "Requester" refers to the individual who requests the lockout/tagout. The requestor may be an individual who only has lockout/tagout responsibility for him/herself or may be the responsible person who has lockout/tagout responsibility for a group of workers.)

When lockout/tagout is required, the requestor contacts the Facility Coordinator who is responsible for the system/item requiring lockout/tagout. The Facility Coordinator then contacts a qualified Safety Operator who performs the required lockout/tagout. At LaRC, the only persons authorized to perform lockout/tagout are Safety Operators who have in their possession a current NASA Langley Form 453, "NASA Langley Safety Operator Permit." Once the lockout/tagout has been completed, the Safety Operator contacts the requestor, communicates the limits of the lockout/tagout, demonstrates the effectiveness of the lockout/tagout, and delivers red tag stub(s), lock box when required, and personal lock(s) to the requestor. When the requestor no longer requires the protection of the lockout/tagout, he/she signs the red tag stub(s) and delivers the signed red tag stub(s), the lock box if used, and personal lock(s) to the Facility Coordinator. The Facility Coordinator contacts the Safety Operator who clears the lockout/tagout.

1.6 ELECTRICAL SAFETY

1.6.1 General Electrical Safety Requirements

Before commencing work on any mechanical equipment or systems, which have electrical connections or contain combustible, or other dangerous gases or fluids, such equipment shall be properly grounded, and/or made safe in accordance with LaRC safety regulations concerning these materials. No work (other than performing routine electrical tasks such as taking electrical measurements, replacing plug-in components, or changing fuses) shall be performed on energized power circuits without prior approval of the Contracting Officer. All references to "qualified electrical," "properly instructed," or "less-qualified" contained in this section shall be as defined in Section 01011, "General and Administrative Requirements".

Only qualified electrical people shall perform the work. If work is planned to be performed on energized circuits, the Contractor shall submit to the Contracting Officer a written application defining the procedure(s) to be used, for approval. Work shall not proceed until approval is received.

The buddy system, a second qualified electrical person directly observing

the operation, is mandatory whenever electrical work (including measurements) is to be performed on energized circuits of 601 volts (phase-to-phase) or higher except as follows:

- o A properly instructed person may accompany electrical personnel in lieu of a qualified electrical person when work such as switching or locking/tagging is being performed.
- o A qualified electrical person may be authorized by their line supervisor to take meter readings without the presence of a second person.

A properly instructed electrical person shall be present when non-electrical work such as grounds-keeping is being performed in an energized substation.

All personnel shall wear safety glasses or goggles when making electrical measurements, inspecting internal wiring of panels, or working with tools in proximity to any energized power circuits. Safety glasses or goggles shall be worn when performing other types of electrical work including control modification and/or checkout.

Identification markings on building light and power distribution panels, circuits, and components for establishing safe work conditions shall not be relied upon.

Ground wires or connections to frames or cases shall not be removed from any energized equipment.

Earth return is not to be used in the wiring of any power circuit.

Temporary electrical wiring shall be supported by suitable wood or other insulating materials.

Temporary electrical wiring and portable electrical cords shall be kept out of water at all times unless the cable is approved by the National Electrical Code (NEC) for that purpose.

When fishing a conductive tape or wire through a conduit, personnel shall be stationed to prevent the free ends of the tape or wire from contacting energized equipment.

All portable electrical tools (except battery operated) shall have ground-fault protection.

The cases of all portable electrical motor-driven hand tools shall be grounded by use of standard three-prong plugs and receptacles and all other electrical equipment supplied with 50 volts or above shall have their cases or frames connected to ground, except:

- o Devices operated solely from self-contained batteries.
- o Devices that have cases and all exposed parts protected by insulating material.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

- o "Double insulated" tools.
- o Devices supplied with less than 150 volts to ground for which exceptions have been granted by the Office of Safety and Facility Assurance.

Tools, equipment, and other potential sources of ignition used in hazardous locations shall comply with Article 500 of NFPA 70, "National Electric Code."

Welding or burning shall not be permitted in the immediate vicinity of electrical equipment unless specifically authorized by the Contracting Officer.

Only devices designed for voltage testing and rated for the nominal voltage of the circuit under test shall be used to make voltage checks. The Contractor shall verify test voltage indicators immediately before and after use by application to an energized circuit or by using an appropriate test unit.

Only fiberglass or wood ladders shall be used near electrical hazards. Metal ladders shall be marked with signs or decals reading CAUTION--DO NOT USE NEAR ELECTRICAL EQUIPMENT. Ladders shall be clean and in good condition.

Portable electrical hand tools shall be unplugged when not in use.

Before maintaining or repairing any electrical equipment, the equipment shall be disconnected from the power source.

Equipment that has frayed cords or three-wire cord ends that have had the grounding prong removed shall not be used. Qualified electrical personnel shall repair faulty equipment and tools.

Lamp replacement or other work or tests shall not be done on the series street lighting system unless the fuse disconnects on the 2,300-volt supply line are properly opened and red tagged.

High-voltage equipment that has been energized and then de-energized shall be grounded prior to performing work, to insure no residual voltage remains as a potential shock hazard.

High voltage areas in buildings shall be screened off or barricaded, to allow only authorized personnel to enter. Electrical and mechanical safety interlocks shall be used where practicable.

Exposed energized circuits shall not be approached closer than the following distances, for any reason, unless such parts are adequately guarded:

Alternating Current	
Voltage Range - Phase-to-Phase	Minimum Distances

600 - 10,000 volts

2 feet

Lineman's type rubber gloves shall be tested at least every 180 calendar days for the circuit voltages involved in accordance with ANSI/ASTM F 496-022, "Standard Specification for the In-Service Care of Insulating Gloves and Sleeves". In addition, a standard air test (ANSI/ASTM F 496-022, "Standard Specification for In-Service Care of Insulating Gloves and Sleeves (2002)") shall be performed immediately before use. Leather protectors shall always be worn over lineman's rubber gloves.

Rubber gloves shall not be relied upon for protection from energized circuits of more than 3500 volts to ground.

Fuses shall not be removed on energized circuits above 600 volts. Fuses shall not be removed from loaded energized circuits. Procedures to be used when removing or replacing fuses on unloaded energized circuits shall conform to the following for circuits:

- o Rated 50 to 600 volts, insulated fuse tongs or extractors manufactured exclusively for fuse removal shall be used.

1.6.2 Special Electrical Safety Requirements

1.6.2.1 Electrical Safety Workers' Qualifications and Duties

All appointed safety workers shall be electrical tradesmen.

- o The Contractor shall appoint a Safety Supervisor knowledgeable of contract safety requirements specified herein. The Safety Supervisor shall be available at the worksite during all work and shall be responsible for the safety of each of the Contractor's work teams.

- o The Contractor shall appoint an Assistant Safety Supervisor who shall take over the responsibilities and perform all duties of the Safety Supervisor if the Safety Supervisor is not present.

- o The Contractor shall furnish to the Contracting Officer, in writing, the names and qualifications of the Safety Supervisor and Assistant Safety Supervisor prior to commencement of work. This submittal is in addition to the Safety Plan required above.

- o When working in energized substations, manholes, and cable tunnels, the Contractor shall:

- o Assign an employee knowledgeable of the safety required, and without other duties, to assist the Safety Supervisor to assure the safety of the work area whenever the work involves the handling of lengths of conduit, bus, steel or large equipment.

- o Assign additional employees, knowledgeable of the safety required and without other duties, for the protection of the workers when the work is so divided and extensive that one safety employee cannot effectively maintain the

safety surveillance over the workers and their operations.

- o Ensure no work is performed without a minimum of two (2) employees present in any one-work team, one of which shall be a safety team leader.

1.6.2.2 Equipment Safety Tests and Checks

The following tests shall be performed prior to energizing electrical equipment for the first time:

- o Initial energizing of all electrical equipment shall be performed in the presence of the Contracting Officer.
- o All power feeder circuit breakers shall be checked for proper adjustment and operation in accordance with the manufacturer's instructions. Molded case circuit breakers without solid state trip devices are excluded from this requirement.
- o All wiring shall be field verified for conformity to the design, fabrication, and functional requirements.

1.6.2.3 Protective System Checks

Protected relay settings shall be coordinated to provide selective tripping. The Contractor shall coordinate this effort through the Contracting Officer.

All circuit interruption devices shall be rated to interrupt the maximum short circuit current of the power system at the point of application of the device.

Circuit breakers shall be immediately inspected and checked to assure suitability for reuse after any operation in which the circuit breaker opens under short circuit or fault conditions. When a trip occurs on breakers above 600 volts, the troubleshooting process shall verify the settings of all breakers between the fault and the breaker when tripped. Molded case circuit breakers without solid state trip devices are excluded from these requirements.

1.6.2.4 High Voltage Insulation Testing of Electrical Equipment

For high voltage dielectric testing, the Contractor shall perform the following actions:

- o Verify lockout/tagout procedure for the applicable circuits.
- o Secure the area.
- o Perform a low voltage dielectric test (Megger test).
- o Perform grounding procedures.

These tests shall be in accordance with Section 5, IEEE Std 95-2002.

1.6.2.5 Rules Governing Contractor Connection Into Government Electrical Utilityess

Prior to connecting into any part of the Government electrical power distribution system, the Contractor shall:

- o Make written application to the Contracting Officer stating the date time, location, and the service desired.
- o Jointly with the Contracting Officer, make the necessary checks of the Contractor's system and the Government's supply to assure their compatibility and safety.

1.6.2.6 Switching

All electrical switching that is required for clearance to work on equipment operating from electrical circuits shall only be performed by Government personnel who have been authorized as LaRC Safety Operators for the specific equipment.

When work is to be performed on secondary circuits or equipment, which are only disconnected from sources of power by oil switches, the following procedures shall be performed:

- o Obtain concurrence from the Contracting Officer.
- o Verify status of de-energized oil switch.
- o Perform tests to verify that there is no voltage on the load side of the transformer from phase-to-phase and from each phase-to-ground.
- o Apply locks/tags. Indicate on the lock/tag that no work shall be performed on the high voltage (primary) side of the equipment.
- o Apply protective grounding as close as physically possible to the load side of the transformer or power source.

1.6.2.7 Removal of Electrical Equipment and/or Wiring

When equipment is designated to be permanently removed, the electrical wiring, conduit, enclosure, and control boxes shall be removed back to the source of feed, unless noted in the drawings or specifications. Where practicable, the power source shall be deenergized and disconnected prior to disconnecting the load or cutting the cables.

1.6.2.8 Energized Substations (2300 Volts and Above)

The Contractor shall:

- o Conform to all applicable OSHA and LaRC safety rules and regulations.
- o Submit a work plan to the Contracting Officer, at least 7 calendar

days prior to initiating work in a substation. Outline the work to be done and identify the circuits required to be deenergized to safely conduct operations. The plan shall include a detailed step-by-step work procedure for each phase of the work. All changes to this work plan shall be reviewed with the responsible LaRC personnel prior to initiation.

- o Appoint an individual responsible for the electrical safety of each work team. The electrical Safety Supervisor(s) shall attend the Construction Safety Briefing. Before starting the work, the responsible individual shall provide a document to the Contracting Officer establishing that the appointed Safety Supervisor(s) is (are) qualified and knowledgeable in OSHA and LaRC safety regulations and requirements. (Refer to paragraph entitled, "Electrical Safety Workers' Qualifications and Duties").
- o Request an electric power outage at least 7 calendar days in advance of the need.
- o After receipt of the lockout/tagout stubs, check to assure that the designated circuits have been deenergized and properly grounded and verify that the immediate work area and a zone beyond the work area have been made safe, before permitting employees to work in the substations. As a minimum, the Contractor shall perform the following:
 - o Install all barriers and rope guards that are deemed necessary to clearly define the work area.
 - o Barriers and rope guards shall be sufficient to restrain the workers from inadvertently moving out of the work area.
 - o Establish a safe zone area between the work area and the energized parts of the substation so that all live circuits and parts clear the designated work area by at least 10 feet.
 - o Use physical barriers whenever practicable. When adequate barriers cannot be installed around all energized parts adjacent to the work area, the Contractor shall take whatever action is needed to provide the continuous safeguarding of each worker.
 - o Assign a full-time employee, knowledgeable of the safety required and without other duties, to assist the Safety Supervisor in assuring the safety of the work area when the work involves handling of lengths of conduit, bus, steel, or large equipment.
 - o Assign additional safety supervisors as needed for the protection of the workers when the work is so divided and extensive that one safety supervisor cannot effectively maintain the safety surveillance over the workers and their operations.
 - o Refrain from using any crane in or near an energized substation where movement of the crane might cause objects to fall into or

strike energized parts of the substation.

- o Contact the Government representative at the beginning of work each day for admittance to the substation. Maintain surveillance of the substation gates to only permit authorized personnel to enter. No entrance shall be made while work is being conducted unless the Contractor Safety Supervisor has been first contacted to verify conditions are safe.

1.6.3 Protective Grounding

1.6.3.1 Definition and Requirements

Equipment normally energized above 600 volts should always be considered energized unless protective grounds are confirmed to be in place. (See LAPG 1710.10, "Safety Clearance Procedures (Lockout/Tagout).") Protective grounds are temporary grounding and short circuiting conductors, which are placed on deenergized electrical equipment for personnel protection. These grounds are a temporary protective measure and should not be confused with the fixed ground system required by NEC. Protective grounds are normally used to prevent accidental energizing of equipment and systems and shall be applied to any equipment when, in the opinion of the worker, the worker's supervisor or the Safety Supervisor, the application is required. If protective grounds are determined to be necessary, they shall be applied before beginning work on systems or equipment which may bring personnel into contact with parts which are normally energized at or above 600 volts.

1.6.3.2 Responsibility

The electrical safety worker shall determine that adequate grounds are placed for the protection of personnel performing work, even though the lockout/tagout may be placed in the name of another person (see paragraph entitled, "Safety Clearance Procedures (Lockout/Tagout)"). Protective grounds shall be placed on all sides of the work where there is a possible source of power (including wire crossings and parallel lines) and as close as possible to the point of work. Additional grounds shall be placed where necessary to reduce static charges or induced voltages from adjacent lines.

1.6.3.3 Method of Application and Removal

Before attaching protective grounds, the equipment or circuit to be protected must be deenergized, tested to verify that the voltage is zero, and locked/tagged out. (See LAPG 1710.10, "Safety Clearance Procedures (Lockout/Tagout)".) All conductors, static wires, circuit neutrals, and cable sheaths shall be connected in a manner which will ground all conductive portions of the circuit to a common point. The protective grounds shall not be removed until all workers are clear of the circuit or equipment. The ground end of the protective grounding cable shall always be connected first and disconnected last. Protective grounding cables shall not be less than 2/0 AWG copper or equivalent.

1.6.3.4 Underground Cables

Protective grounding of conductors in underground cables cannot always be

performed at the point of work. Protective grounds shall be attached at the nearest location where the conductors can be reached. Conductive sheathing or shielding tape shall have a protective ground applied on both sides of the work point.

1.6.4 Underground Electrical

1.6.4.1 General

The conductive sheathing or shielding tape of all energized cables adjacent to the underground work area shall be verified to be grounded prior to commencing work. If ground verification is not feasible, then barriers shall be installed to prevent workers from making contact with energized cables or equipment. If neither barrier erection or ground verification is feasible, all cables adjacent to the work area shall be de-energized.

Code compliant lighting units shall be used when working underground.

Air-driven tools used around energized cables shall be grounded.

Digging permits are required for excavations of 6 inches deep and deeper. (See "Digging Permits", this section).

1.6.4.2 Energized Cables in Manholes

All cables in manholes shall be considered as sources of potential shock. Tests shall be made to verify that there is no voltage between the outer sheaths and grounds.

Even though cables are shown to have no potential between their outer sheath and ground, contact shall be avoided unless necessary to complete some specific item of work. High voltage gloves shall be worn unless the cable has been de-energized.

When cables are being pulled into manholes, a physical barrier shall be provided to prevent contact between existing energized cables and the new cable, cable pulling equipment, and personnel.

1.6.4.3 Cutting and Splicing Power Cables

Splicing or tapping of energized power cables is not permitted. Before cutting into de-energized high voltage cables (above 600 volts) for the purpose of making repairs or removing the cables from the raceway system, workers shall comply with the instructions covering clearing, tagging, testing, grounding, and short circuiting, and shall also comply with the following:

Before piercing or cutting, cables shall be identified by tags, ducts, and/or duct records. Tags and ducts associated with the cables shall be checked against records. Physical checks shall be made on either side of the location where the work is to be performed. When the ends of the high voltage power cable are accessible and can be "open circuited", apply a pulsating test current to the conductor and use a current measuring instrument to positively identify the cable. After

the cable has been identified, either procedure "A" or "B" below shall be followed to assure that the cable is deenergized. After piercing, if no voltage is detected, the cable may be cut.

- o Procedure "A" - Pierce the cable by using a grounded, mechanical, piercing device. The piercing device shall be installed on the cable using rubber gloves or an insulated stick and shall be actuated remotely by an insulated stick or actuating device.
- o Procedure "B" - Rubber gloves shall be worn when removing sheathing or shielding tape, when testing for voltage, and when cutting or piercing cables.
- o A metallic jumper shall be installed to bond the metallic sheathing or shielding tape on each side of the proposed location for cutting the cable.
- o At least 10 inches of sheathing or shielding tape shall be removed for the full circumference of the cable without disturbing the insulation. The cable shall then be tested for voltage with a voltage detector. The voltage detector shall be given a reliability test before and after the voltage test.
- o If no voltage is detected, one-half of the insulation shall be removed. Test the cable for voltage. If no voltage is detected, the cable may be pierced.

1.7 PRESSURE VESSELS

The design, fabrication, inspection, testing, installation, and use of pressure vessels, piping, and associated equipment covered by these specifications shall conform to LAPG 1710.40, Safety Regulations Covering Pressurized Systems.

1.8 DEMOLITION OPERATIONS

Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Government and to prevent damage to adjacent buildings, structures, and other facilities. Demolition operations shall be in accordance with OSHA 29 CFR Part 1926.850 through 1926.859.

1.9 FIRE PREVENTION AND PROTECTION

1.9.1 General Requirements

Fire prevention and protection shall be in accordance with NASA-STD-8719.11, "NASA Safety Standard for Fire Protection".

All hot work, as defined in NASA-STD-8719.11, shall have a "Hot Work Permit" issued by the Fire Department. Hot Work will not be permitted until a Hot Work Permit has been issued and posted. Deviations or waivers from this and the following requirements must be presented to the LaRC Fire

Chief, in writing, for review and consideration. Only the LaRC Fire Chief can grant deviation or waiver approval.

1.9.2 Welding, Flame Cutting and Melting

All welding and cutting operations including, but not limited to, the use of acetylene and propane torches, heat guns, grinders, electric arc welders, and activities such as brazing, shall be done in accordance with the publications of the American Welding Society, and the National Fire Protection Association NFPA 51 and NFPA 51B, Chapter 22 of the "Virginia Statewide Fire Prevention Code" (13 VAC-5-51).

1.9.3 Prohibitions

Hot work activities shall not be performed on the following:

- o Combustible walls or ceilings or those containing combustible insulation.
- o Tanks or pipes that have held flammable liquids, (unless they have been thoroughly purged and tested for residual vapors).
- o Pipes or other metal in contact with combustible materials if ignition of material is possible due to conduction.
- o Metal partitions, walls, ceilings, or roofs having a combustible covering.
- o Walls or partitions of combustible sandwich-type panel construction.
- o Automatic sprinkler systems after initial installation of systems have been completed.

1.9.4 Safeguards

- o Contractor shall remove flammable liquids, oily deposits, and combustible materials within 35-feet of the hot work area.
- o Contractor shall cover or shield combustible materials that cannot be removed with flameproof covers, fire resistant guards, or fire resistant curtains.
- o Contractor shall cover cracks in walls, floors, ducts, or other concealed spaces within 35-feet of the hot work area to prevent the passage of sparks or slag to adjacent areas.
- o Prior to beginning hot work, Contractor shall remove combustible materials from the opposite side of walls, partitions, ceilings or roofs.
- o Nearby personnel shall be protected from heat, sparks, and/or slag, through the use of fire resistive screens or shields.

Special precautions, as recommended by the LaRC Fire Chief and approved by the Contracting Officer, shall be taken to avoid unwanted activation of

automatic detection or suppression systems due to the use of hot work equipment.

1.9.5 Firewatch

The Contractor shall assign a firewatch for every job involving hot work. The firewatch personnel shall not have any other collateral duties to distract or occupy them.

The firewatch personnel shall know the location of fire alarm pull stations in the work area and shall have two fully charged, 10-pound, ABC multi-purpose, dry chemical fire extinguishers available at all times. Facility fire extinguishers shall not be used to satisfy this requirement. The firewatch personnel shall be qualified in the proper use of fire extinguishers for controlling or extinguishing incipient fires.

The firewatch personnel shall continuously monitor the work area for any smoldering fires or hot spots during the period the hot work is being conducted, and for a period of 30 minutes following the termination of the hot work operation. The firewatch personnel shall immediately notify other workers if any dangerous conditions develop, and call the LaRC Fire Department, at 911 on Center telephones or 864-2222 on cellular telephones.

1.9.6 Means of Egress

An unobstructed means of egress in accordance with NFPA 101, "Life Safety Code," shall be maintained at all times, for use by construction workers and LaRC employees.

1.9.7 Fire Protection and Detection Systems

During building alterations and modifications, where the building is protected by fire detection and/or protection systems, such systems shall be maintained in an operable condition at all times. Shut down for any reason shall be pre-approved and coordinated with the LaRC Fire Chief or designee.

If it is necessary to place any existing fire detection or protection system out of service, temporary protection measures such as the termination of all hazardous operations, or frequent inspections of the area involved with a 24-hour per day firewatch may be required by the LaRC Fire Chief or designee.

The Contractor shall make regular checks on the fire sprinkler, and standpipe control valves will be regularly checked at the end of each work period to ascertain that such systems are in service.

If fire sprinkler heads are located within a demolition area, all heads subject to physical damage shall be fitted with guards.

If smoke detectors are located such that dust and/or gases resulting from the construction may adversely affect them, the following procedures shall be adhered to:

- o Place sequentially numbered plastic bags around each smoke detector in the affected area each day before renovation begins.
- o Post manual instructions and inform all Contractor personnel on how to manually signal a fire condition.
- o If the area in question contains a special hazard, an employee of the Contractor shall be dedicated as a firewatch for the period that detectors are bagged.
- o Remove all bags at the end of each work day until renovation work is completed. Bags shall be removed sequentially and recorded, to ensure that every bag is removed.

1.9.8 Portable Fire Extinguishers

The suitability, distribution, and maintenance of portable fire extinguishers shall be in accordance with NFPA 10, "Standard for Portable Fire Extinguishers." The Contractor shall provide and maintain at least one 10-pound, multipurpose dry chemical fire extinguisher in a visible location on each floor of the construction area and at each usable stairway, at all times. The Contractor shall provide and maintain two 4-A, 60-B:C rated fire extinguishers within 25 feet of each asphalt (tar) kettle, during the period such kettle is being utilized, and one additional 4-A, 60-B:C fire extinguisher on the roof being covered. Contractor employees shall be instructed in the proper use of extinguishers.

1.9.9 Temporary Heaters

When open-flame heating devices or other temporary heating equipment are used, the Contractor shall obtain a written permit from the Fire Chief for each use.

- o A list of temporary heating equipment, to be used on-site, shall be provided to the LaRC Fire Chief.
- o The temporary heating equipment shall be installed, used, and maintained in accordance with the manufacturer's instructions, including clearance to combustible material, equipment and/or construction areas.
- o Chimney or vent connectors, where required by direct-fired heaters, shall be maintained at least 18-inches from combustibles and shall be installed in accordance with NFPA 211, "Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances."
- o Oil-fired heaters shall be designed and installed with features in accordance with NFPA 31, "Standard for the Installation of Oil-Burning Equipment."
- o Fuel supplies for liquefied petroleum gas-fired heaters shall be in accordance with NFPA 54, "National Fuel Gas Code," and NFPA 58, "Standard for the Storage and Handling of Liquefied Petroleum Gases."

- o Refueling operations shall be conducted in accordance with NFPA 58.
- o Temporary heating equipment, where utilized, shall be monitored for safe operation and maintained by properly trained personnel.
- o All heating equipment approved by the Contracting Officer, shall be provided with safeguards, such that when tilted or tipped over, their power source will be automatically shut off.
- o Temporary burner-type heaters that are in use during other than normal working hours shall have an hourly firewatch provided.
- o Burner-type heaters are not permitted in areas where painting or similar operations may create an explosive atmosphere.

1.9.10 Removal of Combustible Waste Material

The Contractor shall remove accumulations of combustible waste material including, paper/plastic packing and wrappings, scrap lumber, dust, and other construction rubbish from the structure and its immediate vicinity at the end of each work shift or more frequently as necessary for safe operations.

The Contractor shall promptly dispose of materials subject to spontaneous ignition, such as oily waste and rags used with paint, linseed oil or other flammable or combustible liquids. Such materials shall only be placed in noncombustible receptacles with tight-fitting lids that are physically located away from any building or structure.

1.9.11 Disposal of Rubbish

The burning or incineration of rubbish, such as construction debris, brush, or trees is prohibited on LaRC. The Contracting Officer will provide direction as to the appropriate method of disposal.

1.9.12 Flammable and Combustible Liquids

Flammable and combustible liquids shall be stored and handled in accordance with NFPA 30, "Flammable and Combustible Liquids Code."

Open flames and smoking shall not be permitted in flammable and combustible liquid storage areas. Such areas shall be appropriately posted as "NO SMOKING" areas.

Flammable liquids, including Class I and Class II liquids, shall be kept and transported in the appropriate safety containers as defined in 29 CFR Part 1926.152.

Class I liquids shall be dispensed only where there are no open flames or other sources of ignition within the possible path of vapor travel.

Bulk storage of flammable liquids is prohibited unless the LaRC Fire Chief or designee has granted prior approval.

1.9.13 Smoking

Smoking shall only be permitted in areas designated by the LaRC Fire Chief or designee. The Contractor shall provide receptacles of non-combustible construction designed for collection of waste smoking material.

1.9.14 Non-Emergency Use of Fire Hydrants

Requests for the non-emergency use of fire hydrants shall be made to the LaRC Fire Chief or designee prior to use. Requests may be approved with the following restrictions:

- o The hydrant user shall install one valve on the 4-1/2-inch port on each hydrant to be used. (This 4-1/2-inch port with the valve installed is reserved for LaRC Fire Department use only.)
- o One or both of the 2-1/2-inch fire hydrant ports shall be reserved for non-emergency use. The hydrant user shall provide an approved 2-1/2-inch gate valve on one or both of the 2-1/2-inch fire hydrant ports, reduced down to 1-1/2-inches.

1.9.15 Fire Department Access

Main access roadways shall not be obstructed in any manner.

The Contractor shall provide unobstructed access from the street to fire hydrants and to outside connections for standpipes, sprinklers, or other fire extinguishing equipment, whether permanent or temporary, shall be provided and maintained at all times.

Unobstructed access to the main fire alarm control panel, permanent, temporary, or portable first-aid fire equipment shall be provided and maintained at all times.

1.10 ASBESTOS OPERATIONS

1.10.1 General Requirements

These specifications present criteria for operations involving removal, repair, or other work with asbestos. Asbestos is defined as any material containing more than one- percent asbestos by weight, which is friable during expected handling. All asbestos operations shall be conducted in accordance with Federal, State, and Local regulations applicable to asbestos and including provisions of 40 CFR Part 61 Subpart M, National Emissions Standard for Hazardous Air Pollution; 29 CFR Part 1926.1101 Asbestos; Part 54.1-500 through 1-517 of the Code of Virginia; LAPG 1740.2, Chapter IV, Asbestos; and LAPG 8800.1, Chapter 8, Section 8.3.5 (Environmental Program Manual).

It is the responsibility of the Contractor to ensure that all asbestos removal work is performed thoroughly and conducted properly. The Contractor shall sequence and coordinate asbestos removal operations and other work to ensure that other trades performing renovation work are not exposed to asbestos.

The Contractor shall comply with the Commonwealth of Virginia asbestos handling licensing requirements for contractors, supervisors and workers. The Contractor shall provide a copy of its current asbestos-handling license to the Contracting Officer, prior to beginning on-site operations.

1.10.2 Notification Requirements

Notification of Federal and State regulatory agencies is the responsibility of the contractor involved with the removal/abatement activity.

In work involving friable asbestos material of more than 10 linear feet and/or 10 square feet of insulating surfacing material, Contractor notification to the Commonwealth of Virginia is required. Additionally, the Contractor shall notify the Environmental Protection Agency of renovations involving at least 260 linear feet or 160 square feet respectively.

1.10.3 Operational Procedure

The Contractor shall submit an Asbestos Operational Procedure (AOP) to the Contracting Officer for approval. A Virginia Licensed Asbestos Project Designee shall prepare the AOP, a work plan for asbestos abatement operations. The procedure shall specify how the Contractor will assure compliance with applicable regulations. It shall identify specific control measures and work procedures to be employed in the performance of work. The procedure shall include attention to the following elements as appropriate to the specific job:

- o A work schedule including start and anticipated finish dates
- o Work area control procedures
- o Personal protective equipment and clothing to be worn
- o Description and placement of engineering controls and physical containment elements.
- o Work practices to be observed
- o An air monitoring plan
- o Personal hygiene procedures
- o Labeling
- o Asbestos waste handling and disposal procedures, including a description of the waste and an estimate of volume to be generated

1.10.4 Additional Requirements for Removal of Friable Asbestos

All HEPA vacuums and negative air machines must be dioctyl phthalate tested within 90 calendar days prior to the start of work. Equipment is to be

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

labeled and certification shall be submitted to the Contracting Officer prior to the start of work.

Negative pressure shall be monitored and recorded by a manometer with a strip chart printout. Printout shall be submitted to the Safety and Facility Assurance Office (SFAO) Industrial Hygienist at the end of each phase of the project.

The decontamination unit shall be constructed to provide adequate room for workers to store their street clothes in the clean room. Shower must provide hot and cold running water. Water from the shower shall pass through a two-stage canister style filtration system prior to discharge. It is mandatory that all workers shower prior to exiting the asbestos work area.

All flex duct for negative air exhaust that is to be run through occupied areas shall be new duct material not previously exposed to asbestos contamination.

Asbestos removal contractor must submit written notification to equipment rental companies (e.g., scaffolding, personnel-lifts, and all other rental equipment), concerning the intended use of rental equipment and the possibility of asbestos contamination of the equipment. Copies of the notification shall be provided to the Prime Contractor (if a subcontractor is used) and to the Contracting Officer.

Prior to the establishment of containment and commencement of removal operations, all surfaces within the work area are to be pre-cleaned by wet wiping and HEPA vacuuming.

To the extent it is practicable, the asbestos removal contractor and prime contractor shall coordinate/combine asbestos removal and mechanical demolition.

All equipment (e.g., ladders, staging) brought on-site by the asbestos removal contractor shall be clean with no dirt, dust, or debris present. The equipment must be completely decontaminated prior to being removed from the asbestos work area.

When removal work is conducted in occupied areas, the asbestos removal contractor shall not perform bag-out during the hours of 7:00 a.m. to 5:00 p.m.

When work involves removal and/or reinstallation of transite panels, the Contractor's operational procedure shall include the following precautions:

- o The area behind the panels shall be sealed off with polyethylene (poly) sheeting.
- o Disposable drop cloths shall be placed where the panels are to be removed and at the storage area.
- o Employees performing the work shall be certified asbestos workers wearing Tyvek coveralls and half face negative pressure

respirators with High Efficiency Particulate Air (HEPA) filters.

- o Screw heads, nail heads or other fasteners shall be cut and panels removed intact.
- o All surfaces shall be vacuumed with a HEPA filtered vacuum.
- o The poly placed behind the work area shall be wet wiped or vacuumed. All poly shall be rolled inward to contain any remaining dust and debris.
- o Encapsulment shall be sprayed on both sides of the panels.
- o The area directly around the removal site shall be sprayed. If encapsulment is not used, the same procedures must be utilized for reinstallation as were used during removal.
- o All poly and coveralls shall be disposed of as asbestos waste.

1.10.5 Disposal of Asbestos Waste

Asbestos removed from LaRC removal/abatement sites remains Government property throughout the removal activity and shall be processed as such on the Waste Shipment Record.

Disposal of asbestos waste is the responsibility of the Contractor performing the removal/abatement activity. The Contractor shall follow 40 CFR Part 61, Subpart M and Chapter 8, Section 8.3.5, Asbestos Removal/Abatement Contractor of the Environmental Program Manual, LAPG 8800.1, and all Federal, State and Local regulations applicable. Transportation of asbestos material off-site shall be in accordance with Department of Transportation Regulations (40 CFR Part 173.1090).

Upon request, the Contractor may use an on-site staging area provided by the Government. The Contractor is responsible for the transportation of the properly packaged asbestos waste to the staging area. The Contracting Officer shall provide timely notification to the Contractor, of the location of the on-site staging area to be used for the accumulation of asbestos waste.

The Contractor shall provide a properly prepared waste shipment record which complies with 40 CFR Part 61.150 (d), two calendar days prior to pickup, for the disposal of all Regulated, Asbestos-Containing Material (RACM), which:

1. Identifies NASA, Langley Research Center as owner and waste generator. Address of waste generator shall be:

NASA, Langley Research Center
Office of Environmental Management Office, MS 418
Hampton, VA 23681
Telephone: (757) 864-3394

2. Contains name and address of the local, State or EPA Regional

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Office responsible for administering the asbestos NESHAP program.
Address of responsible agency shall be:

Commonwealth of Virginia Department of Air Pollution Control
P.O. Box 10089
Richmond, VA 23240

3. Contains the name and telephone number of the contractor responsible for the removal of asbestos at the building site.
4. Contains the approximate quantity in cubic meters and in cubic yards.
5. Contains the name and physical site location of the State-approved landfill disposal site.
6. Contains the name, address, and telephone number of the transporter(s).
7. Includes the date transported.
8. Shall be signed by a NASA official in the Environmental Management Office only after completion of all information in Items 1 through 7 above.

1.10.6 Submittals

The Contractor shall provide to the Contracting Officer, the following submittals as required by Section 01330, Submittals, of these specifications, and by applicable law and regulations as cited above:

- o Asbestos Operational Procedure (AOP)
- o A copy of the Contractor's current asbestos handling license issued by the Commonwealth of Virginia.
- o Written proof of required notifications to the Commonwealth of Virginia and the EPA as may be appropriate.
- o Written asbestos waste handling and disposal procedure.
- o Signed certification statement from off-site transporter of asbestos.
- o A copy of the waste shipment record signed by the owner of the disposal facility indicating receipt of asbestos waste by the initial transporter. This copy shall be received by the generator within 35 calendar days of the date the RACM was accepted by the transporter.

1.10.7 Monitoring Requirements

1.10.7.1 Licensed Asbestos Project Monitor

The Contractor shall provide a Virginia Licensed Asbestos Project Monitor having a minimum of two years experience to serve as the on-site Project Monitor for all asbestos related activities. The Project Monitor shall function as an independent third party and shall have no employer-employee relationship or other financial relationship with the asbestos removal contractor (i.e., Project Monitor shall be contracted directly by the prime contractor, not by the asbestos removal contractor.)

The Contractor shall submit to the Contracting Officer a Project Monitoring Plan that describes the air sampling procedures and monitoring methods to be employed to ensure compliance of asbestos operations. The plan shall include documentation of the licenses and professional qualifications for the Project Monitor and written certification from the Project Monitor that no conflict of interest exists in performing as an independent third party monitoring the operations of the asbestos removal contractor.

A licensed Project Monitor is not required for removal of non-friable asbestos materials including roofing material, exterior Transite paneling (where panels are removed intact), and window glazing/caulk.

1.10.7.2 Duties of the Project Monitor

The Project Monitor shall ensure that the asbestos removal work is being conducted in compliance with all applicable State and Federal statutes, regulations and standards pertaining to asbestos removal and disposal. The monitor shall be respirator qualified and enter the containment on a regular basis (at least two times per work-shift) to ensure that the contractor work practices and control methods are appropriate. Problems and deficiencies noted shall be brought to the attention of the asbestos removal contractor and, if immediate corrective action is not taken, shall be documented and reported directly to the Contractor's on-site Superintendent.

The Project Monitor shall be on-site and observe all phases of the asbestos removal work including pre-cleaning, removal, bag-out, final cleaning, and teardown of containment following final clearance. The monitor shall ensure that each phase of the work is conducted properly and adequately.

The Project Monitor shall maintain a daily written log describing all contractor activities and work practices. This log shall be available to the Contracting Officer and his/her representatives for review at any time during the progress of the work. A copy of the log shall be submitted to the Contracting Officer for record at the conclusion of the asbestos removal work.

The Project Monitor shall perform air sampling and report test results as specified.

The Project Monitor shall perform a visual inspection in accordance with ASTM E 1368, Standard for Visual Inspection Following Asbestos Abatement Projects, after the asbestos removal contractor completes fine cleaning in each containment or work area. A written inspection report shall be submitted for review by Safety and Facility Assurance Office (SFAO) Industrial Hygienist prior to encapsulation of the work area and final

clearance air sampling. The Contracting Officer may elect to have SFAO Industrial Hygienist accompany the Project Monitor during final visual inspection.

1.10.7.3 Air Sampling

The Project Monitor shall perform personal (worker breathing zone) and environmental air sampling and shall submit the test results promptly (within 2 calendar days of collection) to Safety and Facility Assurance Office (SFAO) Industrial Hygienist for review. Results shall be faxed to 757-864-8574 or hand delivered to Building 1162T.

Air samples shall be analyzed by Phase Contrast Microscopy by a Virginia Licensed Asbestos Analytical Lab that has successfully participated in the Proficiency Analytical Testing (PAT) Program. Results shall be posted at the job site within 24 hours of sample collection (legible handwritten reports are acceptable). Safety and Facility Assurance Office (SFAO) Industrial Hygienist shall be notified immediately by the Contractor if any outside work area sample result is >0.01 f/cc. Asbestos removal work may be required to stop at no cost to the Government until measures to better control asbestos fiber release are implemented. The following samples are to be collected each day.

- o 2 inside work area samples
- o 2 negative air exhaust samples
- o 2 clean room samples
- o 2 outside work area environmental samples
- o 2 samples to be placed at the discretion of the Project Monitor
- o Personal air sampling in accordance with 29 CFR Part 1926 (Section 01011, General and Administrative Requirements)

1.10.8 Final Clearance

The Safety and Facility Assurance Office (SFAO) Industrial Hygienist will conduct air sampling for final clearance. Aggressive sampling techniques (as defined in 40 CFR Part 763) will be performed in accordance with EPA AHERA Protocols. At the discretion of the SFAO Industrial Hygienist, the air samples will be analyzed by Phase Contrast Microscopy or Transmission Electron Microscopy by a Virginia Licensed Asbestos Analytical Laboratory.

Prior to re-occupancy, Transmission Electron Microscopy samples must average <70 structures/mm² or each Phase Contrast Microscopy sample must contain <0.01 fibers/cc.

The first series of samplings and analysis for final clearance will be provided by the Government. If these samples do not meet the specified criteria for re-occupancy, the entire work area shall be re-cleaned and encapsulated by the Contractor at no additional cost to the Government. The work area will then be re-sampled and the cost of retesting additional samples to verify compliance with the specified criteria for re-occupancy shall be paid by the Contractor.

1.11 USE OF EXPLOSIVES

The use of explosives is not permitted.

1.12 FALL PROTECTION (OSHA 29 CFR PART 1926.500 THROUGH 1926.503)

Fall protection devices and systems shall be in accordance with OSHA 29 CFR Part 1926.500.

The Contractor shall provide fall protection devices and systems for employees in accordance with OSHA 29 CFR Part 1926.501, when working at a height greater than 6 feet.

Body belts are not acceptable as part of a personal fall arrest system. Personnel shall use a full body harness with shock absorbing lanyard.

1.13 LIFTING OPERATIONS

1.13.1 General

Only capable and experienced riggers and equipment operators shall be engaged in on-site lifting operations. In establishing the qualification of such riggers and equipment operators, it is essential that such personnel be knowledgeable about and capable of: determining center of gravity (C.G.) of items to be lifted; determining load weights; calculating lifting line strengths and the margins of safety; calculating sling tension loads; using common slings and hitches; selecting proper sizes and the use of chocks; using hydra-sets; using proof loading specifications; use of hand signals; using and determining strength of knots; using and determining strength of shackles/hooks; and the factors causing distortion of loads (blocking). Personnel involved in these operations shall have at least four years experience in such efforts.

Certification Letter for Operators of Non-Government Owned Lifting Equipment

The Contractor shall provide a certification letter to the Contracting Officer listing all qualified riggers and equipment operators who will be working on-site stating; (1) their years of experience, (2) specialized training, and (3) medical qualifications, (i.e., any visual, hearing, or other physical limitations). This letter shall be submitted to the Contracting Officer prior to on-site lifting operations.

If lifting operations are being conducted in an unskillful manner, the Contracting Officer may, in accordance with FAR Clause 52.236-5, Material and Workmanship, require the Contractor to remove from the work any employee failing to follow appropriate procedures.

1.13.2 Lifting Devices

All Contractor-furnished lifting devices used on-site shall meet the minimum requirements of the applicable ANSI specifications incorporated in OSHA 29 CFR Part 1910, Occupational Safety and Health Standards, Subpart N, Materials Handling and Storage, and OSHA 29 CFR 1926, Safety and Health Regulations for Construction, Subpart N, Cranes, Derricks, Hoists, Elevators, and Conveyors.

All mobile/truck-mounted cranes must have a current annual inspection and "Certification of Load Test". The Certification must be kept on the crane and be made available for inspection by the NASA Inspector or the Safety and Facility Assurance Office Representative upon request. The Safety and Facility Assurance Office shall be notified prior to any mobile/truck mounted crane being brought onto LaRC, at 864-5594 or 864-7233.

The Contracting Officer may inspect at any time, any or all of the Contractor-furnished lifting devices used on-site. If any of the devices do not meet the above requirements, they will be barred from further use until all necessary repairs have been made and they have been reinspected.

Where cranes and derricks are used in or around high-voltage substations, overhead lines, or exposed energized parts, the operations and equipment shall be in accordance with OSHA Subpart N, Paragraph 1926.550, "Cranes and Derricks."

All lifting equipment shall be effectively grounded when being moved or operated in proximity to energized lines or equipment. Consideration shall also be given to grounding the load, particularly if insulated lifting straps are in use.

Lifting equipment shall be operated with a dedicated observer to warn the equipment operator of potentially hazardous situations and/or movements.

1.13.3 Guidelines for Proper Use of A-Frame Type Lifting Devices

A-frames shall be positioned directly over the object to be lifted with the lifting line vertical, the hoist-to-object attachment vertical, or the sling vertical.

Lifts shall be performed through the center of gravity of the object to be lifted or lateral movement restraints shall be imposed to maintain the lifting line vertical.

If the lifted object is to be transported by the A-frame, the center of gravity of the object shall be as low as practical and lateral restraints imposed to maintain the lifting line vertical during transport.

At no time during the use of A-frames shall the lifting line be allowed to get outside of the A-frame base dimensions.

- o A-frames shall be marked with their load capacity rating.
- o A-frames shall be constrained to a 2.5 to 1 height-to-base ratio, to allow the lifting line to be approximately 11 degrees from vertical before an unsafe condition could occur.
- o A-frame base support devices shall be provided for A-frames with wheels, to preclude overturn due to the loss of a wheel when lifting its rated load.

1.13.4 Certification of Qualified Operators of Government Owned Lifting Equipmentt

Prior to using Government owned lifting equipment, all qualified operators shall be certified in accordance with Langley Procedures and Guidelines, LAPG 1740.6, Chapter 8 (Hardware Handler). The Contractor shall submit a list of qualified operators as defined in this section to the Safety and Facility Assurance Office (SFAO) by calling 864-1168 or 864-7233 to be scheduled for NASA safety training and examination in the use of lifting equipment.

Following the 2-hour training session and successful completion of a written exam, the qualified operators shall be scheduled for a visual and hearing acuity examination by the Contractor, and checked out on the specific equipment to be used, by a NASA Facility Safety Head or designee.

Certification Letter for Operators of Government Owned Lifting Equipment

The Contractor shall provide a certification letter to the Contracting Officer stating; (1) the names of the qualified operators, (2) the date of their NASA safety training, and (3) confirmation of their passing the written examination, visual and hearing acuity examination, and having been checked-out on the specific equipment. This letter shall be submitted to the Contracting Officer prior to on-site lifting operations.

1.14 ACCIDENTS AND SAFETY RELATED INCIDENTS

1.14.1 Emergency Response and First Aid Facilities

Contractor employees working onsite may use the Occupational Medical Center for emergency first aid. This facility is located in Building 1149 at 10 West Taylor Street. The telephone number is 864-3196.

To facilitate the rapid notification of emergency responders in the event of a fire, injury or other hazardous conditions, it is recommended the Contractor have a telephone available at the job site.

Emergency response may be obtained by dialing 911 from any Center telephone or by dialing 864-2222 from cellular telephones.

The Contractor shall assure that its personnel are aware of these emergency first aid and emergency response services and shall post the above information conspicuously at the job site.

Accidents shall be reported to the Safety and Facility Assurance Office at 864-7233 as soon as possible. A written report of the accident shall be filed with the Safety and Facility Assurance Office within 3 working days after the accident.

1.14.2 Accident Reporting

All near miss/close call accidents occurring on the Center involving NASA property or equipment, shall immediately be reported to the Safety and Facility Assurance Office at 864-7233.

A near miss/close call accident is defined as a work-related accident that could have caused an injury or property/equipment damage.

1.15 DISPOSAL OF HAZARDOUS WASTE MATERIAL

Disposal of hazardous waste shall be conducted in accordance with Resource Conservation Recovery Act (RCRA) and Federal regulations, State regulations (9 VAC-20-60), and LAPG 8800.1, Chapter 5 (Environmental Program Manual). The Government will be responsible for disposal of all hazardous/regulated waste. Any waste generated by the Contractor at the construction site shall be reported to the Contracting Officer to determine if the waste is regulated or hazardous. The Contractor shall not generate hazardous/regulated waste until it has received written approval and been informed of all applicable regulations concerning the waste generated, by the Environmental Management Office (EMO). The Contractor will be audited by the Environmental Management Office to assure that all RCRA regulations and proper hazardous waste practices are being followed. Contractor shall take appropriate actions to assure compliance with all Hazardous Waste regulations. The Contracting Officer shall be advised of all waste disposal practices at the construction site and will be the liaison between EMO and the Contractor.

The EMO will provide labeled drums at the work site for collection of the liquid solution containing Lithium Bromide (LiBr) from the existing absorption chillers indicated for removal. The Contractor shall drain the chillers completely prior to disassembly and removal and collect the LiBr solution in the drums provided for that purpose. The Contractor shall conduct operations in a manner to avoid spills and shall provide response to control and collect any spill that might occur during these operations. The EMO will pick up the filled drums, accompanied by a completed NASA LF163 disposal form, from the work site for proper disposal. LF163 shall be completed and signed by the Facility Environmental Coordinator (FEC) and the Contractor shall provide a Material Safety Data Sheet (MSDS) for LiBr.

Contractor shall remove all mercury containing devices (such as switches, relays, and gauges) from any electrical/mechanical equipment prior to transporting off LaRC property. EMO will provide labeled containers for accumulation and pickup of devices.

Disposal of hazardous waste into the storm or sanitary sewer is prohibited at all times. Disposal of non-hazardous wastes into sewer systems is authorized only after approval by the Contracting Officer. A permit issued by EMO is required before these waste practices can be permitted. The permit form is Attachment 2 to this section.

1.16 PERSONAL PROTECTIVE EQUIPMENT

Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in accordance with OSHA 29 CFR Part 1926, Safety and Health Regulations for Construction, Subpart E, Personal Protective and Life Saving Equipment, wherever it is necessary by reason of hazards, processes, environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

1.17 SIGNS, SIGNALS AND BARRICADES

1.17.1 Accident Prevention Signs

Contractor shall place signs at locations where hazards exist, as described below. These signs shall be visible at all times when work is being performed and shall be removed or covered promptly when the hazard(s) no longer exists. (OSHA 29 CFR Part 1926.200)

Danger signs shall be used where an immediate hazard exists. Caution signs shall be used to warn against potential hazards or to caution against unsafe practices.

Safety instruction signs shall be used to identify safety requirements relating to the work (e.g., Hard Hats Area, Eye and Hearing Protection Required). Contractor shall post construction areas with legible traffic signs at points of hazard. All traffic control signs or devices used for protection of construction workmen shall conform to AASHTO D-MUTCD-3, Manual for Uniform Traffic Control Devices.

1.17.2 Signaling

When operations are such that signs, signals, and barricades do not provide the necessary protection on or adjacent to a roadway, flagmen or another appropriate traffic control shall be provided. Signaling directions by flagmen shall conform to AASHTO D-MUTCD-3, Manual for Uniform Traffic Control Devices.

1.17.3 Barricades

Barricades shall be used to deter the passage of persons or vehicles from a hazard, such as openings in walls, floors and roof edges. Barricades shall conform to the portions of AASHTO D-MUTCD-3, Manual for Uniform Traffic Control Devices, relating to barricades. (OSHA 29 CFR Part 1926.202)

1.18 HAND AND POWER TOOLS

All hand and power tools and similar equipment shall be maintained in a safe condition. When power operated tools are designed to accommodate guards, they shall be equipped with such guards when in use. (OSHA 29 CFR Part 1926.300)

Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating or moving parts of equipment shall be guarded if such parts are exposed to contact by employees or otherwise create a hazard. Guarding shall meet the requirements as set forth in ASME B15.1, Safety Standard for Mechanical Power Transmission.

1.19 SCAFFOLDING

All scaffolding activities shall be in accordance with OSHA 29 CFR Part 1926.451.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

-- End of Section --

Safety Program Guide
Items That Must Be Addressed
(Unless Totally Inapplicable) On All Safety Plans

Contract Identification - Job title and contract number and a brief summary and scope of the work. The safety representative shall be identified.

Policy - Provide Company's safety policy statement with the plan. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Goals and Objectives - Describe specific goals and objectives to be met. Describe the contractor's approach (including milestone schedule) to achieve and maintain level 5 of the NASA Performance Evaluation Profile in all areas. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Management Leadership - Describe management's procedures for implementing its commitment to safety and health through visible management activities and initiatives including a commitment to the exercise of management control to ensure work place safety and health. Describe processes and procedures for making this visible in all contract and subcontract activities and products. Include a statement from the project manager or designated safety official indicating that the plan will be implemented as approved and that the project manager will take personal responsibility for its implementation. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Employee Involvement - Describe procedures to promote and implement employee (e.g., non-supervisory) involvement in safety and health program development, implementation, and decision-making. Describe the scope and breadth of employee participation to be achieved so that approximate safety and health risk areas of the contract are equitably represented. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Assignment of Responsibility - Describe line and staff responsibilities for safety and health program implementation. Identify any other personnel or organization that provides safety services or exercises any form of control or assurance in these areas. State the means of communication and interface concerning related issues used by line, staff, and others (such as documentation, concurrence requirements, committee structure, sharing of the work site with NASA and other contractors, or other special responsibilities and support). As a minimum, the contractor will identify the following, as required per Appendix H of NPG 8715.3, "NASA Safety Manual":

- a. Safety Representative - Identify by title the individual who will be responsible for the contractor's adherence to Center-wide safety, health, environmental and fire protection concerns and goals, and who will participate in meetings and other activities related to the Center's safety and Health program.
- b. Company Physician - The contractor shall identify their company physician, including name, address and telephone number.

Notice of Violations - The prime contractor shall respond to any Notice of Violation (NOV) issued to them or their subcontractors within 3 working days

from issuance. This response shall be provided to the issuer of the NOV.

SECTION 01060 - ATTACHMENT 1, PAGE 1

Accountability - Describe procedures for ensuring that management and employees will be held accountable for implementing their tasks in a safe and healthful manner. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Voluntary Protection Program (VPP) - The contractor shall explain its approach to comply with the elements of the VPP while working on LaRC, which is a designated VPP Star site. This approach shall include, but is not limited to logs, records, minutes, procedures, checklists, statistics, reports, analyses, notes, or other written or electronic documentation that contains in whole or in part any subject matter pertinent to safety, health, environmental protection, or emergency preparedness. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Workplace Analysis - Describe the method by which hazards, within the contractor's workplace, shall be systematically identified. The identified method shall explain the information collection process through a combination of survey analyses, inspections of the workplace, investigations of mishaps and close calls, and the collection and trend analysis of safety and health data such as: records of occupational injuries and illnesses; reports of spills and inadvertent releases to the environment, facility related incidents, employee reports of hazards. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Hazard Identification - Describe the procedures and techniques to be used to compile an inventory of hazards associated with the work to be performed on the contract. This inventory of hazards shall address the work specified in the contract, as well as, operations and work environments, which are performed in the vicinity or in close proximity to contract operations.

(Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Employee Reports of Hazards - Identification of methods to encourage employee reports of hazardous conditions (e.g., close calls) and analyze/abate hazards. The contractor shall describe steps it will take to create reprisal-free employee reporting with emphasis on management support for employees and describe methods to be used to incorporate employee insights into hazard abatement and motivation/awareness activities. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Inspections - The contract shall include requirements for assignments, procedures and frequency for regular inspections and evaluation of work areas for hazards and accountability for implementation of corrective measures. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Accident Reporting - All serious accidents shall be reported (as soon as possible) to the Safety and Facility Assurance Office at 864-7233. A written report of the accident shall be filed with the Safety and Facility Assurance Office within 3 working days after the accident. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Recordkeeping - The Contractor shall maintain the appropriate records concerning accidents and injuries, in accordance with OSHA 29 CFR 1904.

(Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

SECTION 01060 - ATTACHMENT 1, PAGE 2

Mishap Investigation - Identification of methods to assure the reporting and investigation of mishaps including corrective actions implemented to prevent recurrence. The contractor shall describe the methods to be used to report and investigate mishaps on NASA property and on contractor or third party property. The contractor shall discuss its procedures for immediate notification requirements for fires, hazardous materials spills and releases and other emergencies. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Hazard Prevention and Control - Describe approach to identify, control and/or eliminate hazards in the work place. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Hazardous Operations - Identify hazardous operations to be performed and written procedures developed to ensure the safety and health of employees while performing them. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Flammable Liquid Storage Containers - Flammable liquids shall only be stored in "approved" flammable liquid safety cans that have self-closing spouts.

NASA LaRC Lockout/Tagout System - All contractors/subcontractors shall comply with the NASA LaRC Lockout/Tagout system when performing work on-site, as described in LAPG 1910.10, "Safety Clearance Procedures (Lockout/Tagout). Under no circumstances shall a NASA LaRC Lockout/Tagout device be violated.

Safety Regulations - In addition to OSHA and Federal Regulations, the Contractor shall adhere to all applicable State, Local and Langley Research Center Safety Regulations. (Required per Appendix H of NPG 8715.3, "NASA Safety Manual.")

Confined Space Entry - Confined spaces shall not be entered until a Confined Space Entry Permit has been obtained. The Contractor shall have personnel trained in confined space entry, shall provide the permit and conduct initial and hourly readings as required by OSHA 29 CFR 1910.146.

Crane Certification - All mobile/truck-mounted cranes shall have a current "Annual Certification of Load Test". The Certification shall be kept on the crane and be made available for inspection by the NASA Inspector or the Safety and Facility Assurance Office Representative upon request. The Safety and Facility Assurance Office shall be notified immediately when any mobile/truck mounted crane is brought onto the Center, at 864-5594 or 864-7233.

Scaffolding - When scaffolding is required, it shall be designed, constructed and assembled in accordance with OSHA 29 CFR 1926.450 through 454.

Excavations and Trenching - Surface penetrations of 6 inches or more require a "Digging Permit" and shall follow all applicable standards under OSHA 1926.650-652.

Material Safety Data Sheets (MSDS) - A MSDS shall be available for each chemical, oil, lubricant, solvent, etc., used on the job-site. (Required per

Appendix H of NPG 8715.3, "NASA Safety Manual.")

SECTION 01060 - ATTACHMENT 1, PAGE 3

Fall Protection - When fall protection is required, the Contractor shall comply with OSHA 29 CFR 1926.500 through 1926.503, which defines the types of fall protection devices and systems. Personnel shall use a full body harness with shock absorbing lanyard.

Extension Cords and Ground Fault Protection - All extension cords shall be the three wire grounded type and be in good working order (No broken or missing pins). Extension cords or other temporary wiring shall be protected by a Ground Fault Interrupt (GFI) device.

Subcontractor Compliance - All subcontractors shall comply with the Prime Contractor's Safety Plan.

Safety Meetings - The Contractor shall hold weekly safety meetings.

Hazardous Communications Program - The Contractor shall furnish a copy of his hazardous communications program as defined in CFR 29 Part 1910.1200.

Floors, Openings, Etc. - Unprotected openings in walls, floors or roof edges shall be guarded using standard handrails, barricades, or equivalent protection.

Steel Erection - When steel erection is required, it shall be performed in accordance with OSHA 29 CFR 1926.750 through 1926.752.

Personal Protective Equipment - When required, the appropriate PPE shall be used in accordance with OSHA 29 CFR 1926 Subpart E.

Hot Work Permit - Hot Work will not be permitted until a Hot Work Permit has been issued by the Fire Department, approved and posted. Deviations or waivers from this and must be presented to the LaRC Fire Chief, in writing, for review and consideration. Only the LaRC Fire Chief can grant deviation or waiver approval.

Appendix H, NPG 8715.3, "NASA Safety Manual" may be viewed at:
http://nodis3.gsfc.nasa.gov/library/displayDir.cfm?Internal_ID=N_PG_8715_0003_&page_name=AppendixH

SEWER DISPOSAL PERMIT

PART ONE (TO BE COMPLETED BY REQUESTOR)

1. Name of material_____
2. Quantity_____
3. Date(s) of proposed disposal_____
4. Analytical Data: MSDS___ Laboratory Analysis___ Attached___ (Check at least one)
5. Sanitary Sewer_____ Storm Sewer_____
6. Signature of Requestor_____
7. Organization_____
8. Date_____

PART TWO (TO BE COMPLETED BY THE ENVIRONMENTAL MANAGEMENT OFFICE)

Authorization for disposal of the material described above is granted. Any deviation invalidates this permit.

Environmental Management Office

Date

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01330

SUBMITTALS

PART 1 GENERAL

1.1 SUMMARY

1.2 SUBMITTAL PREPARATION AND CONTENT

1.2.1 Technical Submittals

1.2.2 General

1.2.3 Calculations, Drawings, Data, and Other Contractor Submittals

1.2.3.1 Calculations and Drawings

1.2.4 Submittal Descriptions (SD)

1.3 MARKING

1.4 SUBMITTAL REQUIREMENTS

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section Table of Contents --

SECTION 01330

SUBMITTALS

PART 1 GENERAL

1.1 SUMMARY

This section defines and explains the general submittal requirements applicable to all submittals under this contract. Specific submittals required are set forth by the various administrative or technical sections of this specification, the contract drawings, or other portions of this contract. Accordingly, the Contractor shall make timely and complete submittals as required by all applicable contract provisions.

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTAL PREPARATION AND CONTENT

1.2.1 Technical Submittals

All technical submittals, for action of the Contracting Officer, shall be submitted on the Langley Technical Submittal Form (see Attachment 1). The actual transmittal form for this project will be transmitted to the successful bidder at the time of Notice to Proceed.

The technical submittal form shall serve as the Contractor's cover sheet and also the Government's approval/review sheet back to the Contractor.

The Contractor shall submit one technical submittal form cover sheet for each package of submittals.

Technical submittals shall be grouped by specification section, limited to eight (8) submittals per cover sheet from one specific specification section.

The Contractor shall complete the item number, specification section and paragraph number, SD number and description for each item submitted.

The Contractor shall note any specification deviation included in the submittal package.

1.2.2 General

All submittals shall be in the English language.

Submittals become the property of the Government. The Government reserves the right to duplicate, use, and disclose, in any manner and for any

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

purpose, shop drawings delivered under this contract. Wording such as "Confidential", "Do not reproduce", and similar statements shall not be included on the submittals. Submittals that prohibit duplication will be returned to the Contractor for correction and resubmitting. Refer to FAR 52.236-1, Performance of Work by the Contractor, for additional information.

The Contractor shall specifically point out variations of submittal items from contract requirements in transmittal letters. Failure to point out deviations may result in the Contracting Officer requiring rejection and removal of such work at no additional cost to the Government.

The Contractor shall allow 30 calendar days for review of submittals. If the Contractor deems a submittal critical or urgent (e.g., to order long lead-time items; enter into firm subcontracts or supplier purchase orders), it shall so state on the letter or form transmitting such submittal and shall indicate its priority for the items submitted.

The Contracting Officer will, after receipt of submittals, return one copy to the Contractor marked "Reviewed", "Approved," "Approved with corrections as noted," "Reviewed with corrections as noted," or "Returned for corrections," which shall be interpreted as follows:

Submittals marked "Reviewed" authorize the Contractor to proceed with the work covered by such submittals.

Submittals marked "Approved" authorize the Contractor to proceed with the work covered by such submittals.

Submittals marked "Approved with corrections as noted" or "Reviewed with corrections as noted," authorize the Contractor to proceed with the work covered by such submittals in accordance with the corrections indicated thereon. The Contractor shall make the corrections to the submittals and resubmit them to the Contracting Officer within fifteen calendar days after receipt of the marked submittals.

Submittals marked "Returned for correction" require the Contractor to make the necessary corrections and revisions to the submittals and to resubmit them for approval by the Contracting Officer.

Where the submittal is for Information, the Government may indicate recommended corrections, or take no action, at its discretion. The Contractor may proceed with the work without response from the Government.

Government review or approval does not relieve the Contractor of responsibility for the accuracy and correctness of submittal data furnished or for compliance of the submittal's subject items with all applicable contract requirements.

Where review of the submittals is indicated, the Contracting Officer will notify the Contractor of any recommended corrections within 30 calendar days after receipt. If the Government takes no action within 30 calendar days, the Contractor may assume Government acceptance and proceed with the work.

Where Approval of submittals concerning materials, drawings, or other submittals is required prior to work execution, the Contractor shall not proceed with the affected work until such approval is received from the Contracting Officer. Government action will be taken within 30 calendar days.

Partial Submittals will not be accepted for expediency of the contract's completion.

1.2.3 Calculations, Drawings, Data, and Other Contractor Submittals

The Contractor shall collect the required data submittals for each specific material, product, unit of work, or system into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical.

1.2.3.1 Calculations and Drawings

As required by these specifications, the Contractor shall prepare all calculations and/or drawings to fabricate, assemble and install all parts of the work, in such detail that will enable the Contracting Officer to understand and check conformity with the contract specifications.

The Contractor shall collect copies of the calculations and computations in booklet form, arranged to show electrical, mechanical, and structural/architectural divisions.

When action on submittals is taken by the Contracting Officer, each copy of drawings/calculations will be identified as having received such action by being so stamped and dated. The Contractor shall make any corrections required by the Contracting Officer. If the Contractor considers any correction indicated to constitute a change to the contractual requirements, the Contractor shall promptly notify the Contracting Officer and shall not proceed with the work covered thereby until directed to do so. The approval of the drawings by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of adequate connections, and details, and satisfactory construction of all work.

The drawings shall be made by using the AutoCAD drafting program and be of such quality of workmanship to permit the making of legible reproductions and revisions without impairing their usefulness. Drafting standards employed shall permit reducing the drawing to a 35mm negative from which a full size enlarged print can be reproduced without loss of resolution of the information contained thereon.

The drawings shall be submitted on white bond paper, not less than 8½ by 11 inches in size, not larger than 22 by 34 inches in size, except for full size patterns or templates.

Shop drawings shall be prepared in accurate size, with scale indicated, except where other form is required. A responsible representative of the Contractor shall sign all drawings.

Drawing reproducibles shall be suitable for microfilming and reproduction and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

- a. The job name, which shall be the general title of the contract drawings.
- b. The date of the drawings and revisions.
- c. Name of Contractor.
- d. Name of Subcontractor and/or manufacturer.
- e. The name of the item, material, or equipment detailed thereon.
- f. The number of the submittal (e.g., first submittal) in a uniform location adjacent to the title block.

The Contractor shall submit drawings in a sequence that will permit the work to proceed in an orderly manner consistent with the sequence of events as scheduled on the Contractor's scheduling technique required by this contract.

1.2.4 Submittal Descriptions (SD)

Submittal Description (SD): These are drawings, diagrams, layouts, schematics, catalog cuts, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the contractually required work.

The following items are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification section.

SD-01 Data

General:

Submittals which provide calculations, descriptions, or other documentation regarding the work.

Manufacturer's Catalog Data:

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

Design Data:

Design calculations, mix design analyses, or other data pertaining to a part of the work.

Recertification Status Sheets:

Tabular summary of component data including: end connections, manufacturer, description, material, installation date, allowable working pressure, and code compliance.

SD-04 Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work. Drawings may include the types of graphically depicted information discussed below.

The drawings shall be coordinated with the wiring diagrams of the equipment furnished under sections of Division 15 and Division 16.

Connection Diagrams

Connection diagrams shall indicate the relations and connections of devices and apparatus. They shall show the general physical layout of all controls, the interconnection of one system, or portion of system, with another, and all internal tubing, wiring, and other devices.

Control Diagrams

Control diagrams shall show the physical and functional relationship of equipment. Electrical diagrams shall show size, type, and capacity of the systems. Pneumatic diagrams shall be furnished where air or gas systems are used.

Interconnection Diagrams

Interconnection diagrams shall indicate, to scale, interface between associated units of equipment and between equipment and systems.

Schematics

Schematic drawings shall depict the functional flow of systems and their interfaces with facilities and other systems. Functional and physical interfaces shall be indicated. Schematics need not be to scale. Schematics may be structural, mechanical, electrical, or a combination of these.

Fabrication/Erection/Installation Drawings

Fabrication, erection, installation, and checkout drawings and specifications shall indicate equipment arrangement, with elevations, sections, and enlarged details. Details shall indicate proper methods

of fabrication, construction, and installation.

As-Built Contract Drawings

The As-built Contract Drawings shall provide current factual information including deviations from, and amendments to the drawings and changes in the work, concealed and visible.

The As-built Contract Drawings shall accurately reflect the current configuration of the design and construction, and shall be red-lined concurrently with any changes being made. The Contractor shall implement an established drawing control process to ensure that design changes are communicated to construction personnel and to the Government for approval in a timely manner.

The As-Built Contract Drawings shall be maintained at the construction site, and shall be available for inspection any time by the Contracting Officer. The Contractor shall submit one (1) copy of these marked up drawings to the Contracting Officer at the end of the contract period for Government review and approval prior to final payment and acceptance of the contract. These drawings shall be stamped "AS-BUILT CONDITIONS" on each sheet or page, dated, and signed by the Contractor.

Pressure Systems Drawings:

Pressure systems drawings shall be an isometric depiction of the pressure piping system as installed. The drawing shall include all system components, each uniquely numbered, including supports and all other specific elements which represent the as-built configuration. Component numbering shall be continuous throughout the system.

SD-06 Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any, concerning impedances, hazards, and safety precautions.

SD-07 Schedules

Tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

SD-08 Statements

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other subcontractor, to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications, or other verification of quality. This shall include plans or other documentation to ensure compliance with local, state, and federal safety laws and regulations.

SD-09 Reports

General:

Reports of inspections and/or laboratory tests, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

Test Reports:

A report signed by an authorized official of a testing laboratory that a material, product, or system identical to the material, product, or system to be provided has been tested in accordance with requirements specified by naming the test method and material. The test report must state the test was performed in accordance with the test requirements; state the test results; and indicate whether the material, product, or system has passed or failed the test. Testing must have been within 3 years of the date of award of this contract.

Factory Test Report:

A written report which includes the findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for this project before it is shipped to the job site. The report must be signed by an authorized official of the manufacturer or an independent testing laboratory and must state the test results. The report shall also indicate whether the material, product, or system has passed or failed the test. These reports shall be subject to approval of the Contracting Officer, unless otherwise specified herein, before delivery of the materials or equipment. This approval shall not relieve the Contractor of the obligation to meet all the requirements of the contract.

Field Test Report:

A written report which includes the findings of a test made at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation. The report shall be signed by an authorized official of a testing laboratory or agency, must state the test results, and indicate whether the material, product, or system has passed or failed the test.

SD-13 Certificates

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meets specified requirements. The statements must be dated after award of contract, name the project, and list the specific requirements.

SD-18 Records

Documentation required for contract administration.

1.3 MARKING

Marking shall be provided for each submittal to identify it by contract number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s); submittal name; specification section and paragraph reference; drawing reference; and similar information to distinguish it from other submittals and to identify its contractual requirement source(s).

1.4 SUBMITTAL REQUIREMENTS

The following submittal summary chart itemizes the general and specific submittal requirements under this contract. The following letter codes designate the Government addressee(s) and Mail Stop(s):

- A - Contract Administrator, Mail Stop 126
- B - Contracting Officer Technical Representative, (COTR), Mail Stop 465
- C - Safety and Facility Assurance Office, Mail Stop 429
- D - Construction Services Unit, Mail Stop 428
- E - Accounts Payable and Employee Services Branch, Mail Stop 175
- F - Office of Environmental Engineering, Mail Stop 418

The number following the letter code, as shown in the submittal summary chart, specifies the number of copies to be provided, (i.e., B-6). The required number of all submittals shall be delivered prepaid to Langley Research Center, Hampton, Virginia 23681-0001 addressed to the appropriate recipient and Mail Stop number as shown above.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
SD-01, Data					
General Data	**	---	B-3	Approval	15972
Equipment and Performance Data	**	---	B-6	Approval	15720,15950 16124,16225 16286
Design Analysis	**	---	B-6	Approval	15626
Design Calculations	**	---	B-6	Approval	15626
Manufacturer's Catalog Data	30 Days Before Installation	---	B-6	Approval	15050,15080 15125,15626 15628,15720 15818,15972 16124,16225 16286,16345
SD-04, Drawings					
Connection Diagrams	**	---	B-6	Approval	15626,15628 16286,16345
Control Diagrams	**	---	B-6	Approval	15972
Schematics	**	---	B-6	Approval	15972
Fabrication/ Erection/ Installation Drawings	**	---	B-6	Approval	15720,15818 16286
As-Built Drawings	Prior to Contract Completion	---	B-6	Approval	01011,15050 15972
Isometric Weld Map	7 Days After Acceptance	---	B-1	Review	15055
SD-06, Instructions					
Manufacturer's Instructions	**	---	B-6	Review	16286,16345
SD-07, Schedules					

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
Material, Equip- ment, and Fixture Lists	**	---	B-6	Review	15050,15818
SD-08, Statements					
Material and Equipment Substitutions	Before Field Use	---	B-6	Approval	01011
Application for Making Connection to Utilities	**	---	B-5, C-1	Approval	01011,01060
Utility Outage Requests	7 Days Before Desired Outage	---	D-2	Approval	01011,01060
Plumbing Worker's Qualifications	Prior to Site Work	---	B-1, C-1	Approval	01011
Electrical Worker's Qualifications	Prior to Site Work	---	B-1, C-1	Approval	01011
Mechanical Worker's Qualifications	Prior to Site Work	---	B-1, C-1	Approval	01011
Safety Plan	Prior to Award	---	A-3	Approval	01060
Application for Work on Energized Circuits	Prior to Work Start	---	B-6	Approval	01060
Electrical Safety Worker's Qualifications	Prior to Work Start	---	B-5, C-1	Approval	01060
Energized Sub- stations Work Plan	**	---	B-6	Approval	01060
List of Riggers	14 Days Before	---	B-2, C-1	Approval	01060

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
Lifting Ops.					
Welding/Brazing					
Welding/Brazing Procedure Specifications & Procedure Qualification Records (WPS), (PQR)	15*	---	B-2	Approval	15055
Welder/Brazer Performance Qualification Records (WPQ)	15 Days Before Welding Work	---	B-2	Approval	15055
SD-09, Reports					
Field Test Report	5 Days After Test	---	B-6	Review	15050,15055 15626,15628 15950,16124 16145,16286
SD-13, Certificates					
Certificates of Compliance	30 Days Before Installation	---	B-6	Review	15950,16124 16145,16225 16286,16345
SD-18, Records					
Invoices	Monthly	---	E-2	Approval	01011
Contractor Release Form	At Contract Completion	---	E-1	Review	01011
Price Breakdown for Modification Proposals	14 Days After Change or Proposal Request	---	A-2	Approval	01011
Price Breakdown for Progress Payments	**	---	A-6	Approval	01011

SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
Order Status Reports	**	---	B-3	Information	01011
Schedule of Construction	30*	---	A-1, B-5	Approval	01011
Monthly Progress Schedules	30*	15th Day of Each Month	A-1, B-5	Review	01011
Monthly Technical Progress Narratives	30*	15th Day of Each Month	A-1, B-5	Review	01011
Certified Payrolls	Weekly	---	D-2	Review	01011
Record of Existing Conditions	Before Site Work	---	B-6	Approval	15050,15818 15950
SD-19, Operation and Maintenance Manuals	30 Days Prior to Onsite Const.	30 Days Prior to Contract Completion	B-4	Review	01011,15050 15626,15628 15720,15818 15972,16286

NOTE: Submittal Summary requirements are listed in Calendar Days.

* Calendar days after date of receipt of Notice to Proceed

** As required by specifying section with updates when significant changes occur

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

Technical Submittal Form					Date Received: Distribution:		
TO:							
FROM:							
Contract No.:		Title:					
TO BE COMPLETED BY CONTRACTOR							
Submittal <input type="checkbox"/> New <input type="checkbox"/> Previous		Submittal Number:		Previous Submittal Number:			
Item #	Specification Section Para No./Dwg. No.	SD No.	Description of Material (Include Type, Model No., Catalog No., Mfg., Etc.)	Action Code	Initials		
Contractor Representative:			Signature:		Date:		
Government Action Codes:			A-Approved; AC-Approved with corrections as noted; R-Returned for corrections; RE-Reviewed; RC-Reviewed with comment				
FOR GOVERNMENT USE ONLY							
To Reviewer:			M/S:	To Reviewer:		From Reviewer:	
				Date:		Date:	
Comments							
Reviewer:			Signature:		Date:		
Approval (<i>Name and Title</i>):			Signature:		Date:		

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

-- End of Section Table of Contents --

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Reference publications are cited in other sections of the specifications along with identification of their sponsoring organizations. The addresses of the sponsoring organizations are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

4301 North Fairfax Dr., Suite 425
ATTN: Pubs Dept.
Arlington, VA 22203
Ph: 703-524-8800
Fax: 703-528-3816
E-mail: ari@dgsys.com
Internet: www.ari.org

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

30 W. University Dr.
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 or 202-624-5800
Fax: 800-525-5562 or 202-624-5806
Internet: www.aashto.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001
Ph: 312-670-2400
Publications: 800-644-2400
Fax: 312-670-2400
Internet: http://www.aiscweb.com

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

11 West 42nd St
New York, NY 10036
Ph: 212-642-4900
Fax: 212-302-1286
Internet: <http://www.ansi.org/>

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

1791 Tullie Cir., NE
Atlanta, GA 30329-2305
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
Internet: <http://www.ashrae.org>

AMERICAN WELDING SOCIETY (AWS)

550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353
Fax: 305-443-7559
Internet: www.amweld.org

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

600 No. 18th St.
P.O. Box 2641
Birmingham, AL 35291-0992
Ph: 205-257-2530
Fax: 205-257-2540
Internet: <http://www.aeic.org/index.htm>
E-Mail: veazey-white@apc.com

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
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Fax: 732-981-9667
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E-mail: customer.service@ieee.org

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO))

1, rue de Varembe'
Case Postale 56
CH-1211 Geneve 20
Switzerland
Internet: www.iso.ch

JOINT INDUSTRIAL COUNCIL (JIC)

Association for Manufacturing Technology
7901 Westpark Dr.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

McLean, VA 22102
Ph: 703-893-2900
Fax: 703-893-1151

LANGLEY RESEARCH CENTER (LaRC)

100 Nasa Road
Hampton, VA 23681-2199
Ph: 757-864-1000

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

127 Park St., NE
Vienna, VA 22180-4602
Ph: 703-281-6613
Fax: 703-281-6671
Internet: [//cssinfo.com/info/mss/html](http://cssinfo.com/info/mss/html)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Publication(s) Available From
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
Ph: 202-783-3238

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 202-841-3300
Internet: <http://www.nema.org/>

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Ph: 800-344-3555
Fax: 800-593-6372
Internet: <http://www.nfpa.org>

UNDERWRITERS LABORATORIES (UL)

333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: <http://www.ul.com/>
Order from:
Global Engineering Documents
15 Inverness Way East

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: <http://global.ihs.com>
E-mail: global@ihs.com

VIRGINIA ADMINISTRATIVE CODE (VAC)

910 Capitol St. Fl 2
Richmond, VA
Ph: 804-786-3591

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15003

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS (Not Applicable)
- 1.3 COORDINATION
- 1.4 MECHANICAL SYSTEMS IDENTIFICATION
 - 1.4.1 Identification Tags
 - 1.4.2 Service Labeling
- 1.5 COLOR CODING
- 1.6 APPROVAL REQUIREMENTS
- 1.7 PREVENTION OF CORROSION
- 1.8 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS
- 1.9 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

PART 2 PRODUCTS

- 2.1 IDENTIFICATION PLATES
- 2.2 ANCHOR BOLTS
- 2.3 PAINTING

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 EQUIPMENT PADS
- 3.3 CUTTING AND PATCHING
- 3.4 CLEANING

-- End of Section Table of Contents --

SECTION 15003

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1 (1981; R 1993) Scheme for the
Identification of Piping Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123 (2000) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

ASTM B 766 (1986; R 1993) Standard Specification for
Electrodeposited Coatings of Cadmium

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 82 (1996) Protection of Stratospheric Ozone

MILITARY SPECIFICATIONS (MS)

MS MIL-T-704 (Rev K) Treatment and Painting of Material

MILITARY STANDARDS (MIL-STD)

MIL-STD 101 (Rev B) Color Code For Pipelines and For
Compressed Gas Cylinders

UNDERWRITERS LABORATORIES (UL)

UL 6 (2000) UL Standard for Safety - Rigid
Metal Conduit

UL-02 (1995) Building Materials Directory

1.2 SUBMITTALS (Not Applicable)

1.3 COORDINATION

Contractor shall coordinate the work of the different trades so that

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and all fittings required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.4 MECHANICAL SYSTEMS IDENTIFICATION

1.4.1 Identification Tags

Identification tags made of brass or aluminum indicating function of a control or similar component shall be installed on such system devices. Tags shall be 2 inches in diameter and marking shall be stamped.

Equipment shall be provided with metal identification tags displaying an equipment designation number matching drawing or control diagram designation.

Tags shall be wired to valve or equipment items with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire.

1.4.2 Service Labeling

All piping, including that concealed in accessible spaces; exposed, bare and painted; and insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels and valve tag schedule shall be in accordance with the typical examples below:

<u>SERVICE</u>	<u>LABEL AND TAG DESIGNATION</u>
Automatic temperature control	AUTO. TEMP. CONTROL
Chilled water-supply	CHILLED WATER-SUPPLY
Chilled water-return	CHILLED WATER-RETURN
Cooling tower water-supply	C TWR WATER-SUPPLY
Cooling tower water-return	C TWR WATER-RETURN
Condenser water supply	COND. WATER SUPPLY
Condenser water return	COND. WATER RET
Condensate drain	COND. DRAIN
Low pressure steam supply	LPS
Low pressure condensate	LPC
High pressure steam	HI-PRESS. STEAM (125 PSI)
Steam condensate return	STEAM CONDEN. RETURN

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Similar services with different temperatures or pressures shall be identified. Where pressures may exceed 125 pounds per square inch, gage, the maximum system pressure shall be included in the label.

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit of pipe passing through walls

Each change in direction, i.e., elbows, tees

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

<u>For Bare or Insulated Pipes for Outside Diameters of</u>	<u>Lettering</u>
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

Labels shall be made of self-sticking, plastic film designed for permanent installation.

1.5 COLOR CODING

Color coding of all piping systems shall be in accordance with ANSI A13.1 or MIL-STD 101.

1.6 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL-02, and UL 6 will be acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations and cadmium-plated in conformance with ASTM B 766 for interior locations.

1.8 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS

Releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's will be minimized by complying with all applicable sections of 40 CFR Part 82 Subpart F, Recycling and Emissions Reduction. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA comply with the following:

No Class I or Class II substances used as a refrigerant may be knowingly vented or otherwise released into the environment.

No appliances may be opened without meeting the requirements of 40 CFR Part 82.156 Subpart F, Required Practices, regarding required practices regarding evacuation and collection of refrigerant, and 40 CFR Part 82.158 Subpart F, Standards for Recycling and Recovery Equipment, regarding standards of recycling and recovery equipment.

No work may be conducted on appliances containing refrigerant except by persons who comply with 40 CFR Part 82.161 Subpart F, Technical Certification, regarding technician certification.

In addition, copies of all applicable certifications must be provided to the Contracting Officer at least 10 working days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

Proof of Technician Certification

Proof of Equipment Certification, if recovery or recycling equipment is to be provided by the Contractor

Proof of availability of certified recovery or recycling equipment, if equipment is to be provided by the Contractor

1.9 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

The use of Class I or Class II ODS's listed as nonessential in 40 CFR Part

82.66 Subpart C, Nonessential Class 1 Products and Exceptions, is prohibited. These prohibited materials and uses include:

Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays

Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial

Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

A waiver may be requested should a programmatic of facility requirement dictate that a prohibited material is necessary to achieve project goals. A waiver request must be submitted in writing to the Test Operations and Institutional Safety Branch. The waiver will be evaluated and dispositioned by a Hazardous Materials Review subcommittee.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each piece of mechanical equipment. Identification plates shall designate the function of the equipment. Designation shall be submitted with the shop drawings.

Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger shall have beveled edges. Identification plates shall be installed using a compatible adhesive.

2.2 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.3 PAINTING

Equipment units shall be painted in accordance with MS MIL-T-704 or in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouching shall be accomplished only if approved; otherwise equipment shall be returned to the factory for refinishing.

PART 3 EXECUTION

3.1 INSTALLATION

Materials and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 EQUIPMENT PADS

Equipment pads shall be provided and shall be of dimensions shown or, if not shown, they shall conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports.

3.3 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching of the building structure.

Holes in exposed locations, in or through existing floors, shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

Holes through masonry walls to accommodate sleeves shall be made with an iron pipe masonry core saw.

3.4 CLEANING

Exposed surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish painting or are enclosed within the building structure.

Before final acceptance, mechanical equipment, including piping, ducting, and fixtures, shall be clean and free from dirt, grease, and finger marks.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 PIPE AND FITTINGS
 - 2.1.1 Type BCS, Black Carbon Steel (Chilled, Steam, Cooling Tower)
 - 2.1.2 Type BCS-125, (125-psi Service)
 - 2.1.3 Condensate Drain
 - 2.1.3.1 Polyvinylchloride (PVC-DWV)
- 2.2 PIPING SPECIALTIES
 - 2.2.1 Dielectric Connections
 - 2.2.2 Pressure Gages
 - 2.2.3 Sleeve Couplings
 - 2.2.4 Thermometers
 - 2.2.5 Line Strainers, Water Service
 - 2.2.6 Line Strainers, Steam Service
- 2.3 VALVES
 - 2.3.1 Ball and Butterfly Valves
 - 2.3.2 Drain, Vent, and Gage Cocks
 - 2.3.3 Gate Valves (GAV)
 - 2.3.4 Air Vents
- 2.4 MISCELLANEOUS MATERIALS
 - 2.4.1 Bolting
 - 2.4.2 Elastomer Caulk
 - 2.4.3 Flange Gaskets
 - 2.4.4 Pipe Thread Compounds
- 2.5 SUPPORTING ELEMENTS
 - 2.5.1 Building Structure Attachments
 - 2.5.1.1 Anchor Devices, Concrete and Masonry
 - 2.5.1.2 Beam Clamps
 - 2.5.1.3 C-Clamps
 - 2.5.1.4 Inserts, Concrete
 - 2.5.2 Horizontal Pipe Attachments
 - 2.5.2.1 Single Pipes
 - 2.5.2.2 Parallel Pipes
 - 2.5.3 Vertical Pipe Attachments
 - 2.5.4 Hanger Rods and Fixtures

2.5.5 Supplementary Steel

PART 3 EXECUTION

- 3.1 PIPE INSTALLATION
- 3.2 VALVES
- 3.3 SUPPORTING ELEMENTS INSTALLATION
- 3.4 PENETRATIONS
- 3.5 SLEEVES
- 3.6 DISINFECTION

-- End of Section Table of Contents --

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328 (1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105/A 105M (2001) Standard Specification for Forgings, Carbon Steel, for Piping Components

ASTM A 126 (1995; R 2001) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A 197 (2000) Standard Specification for Cupola Malleable Iron

ASTM A 197/197M (2000) Standard Specification for Cupola Malleable Iron

ASTM A 234/A 234M (2000) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM A 278 (2001) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degrees F

ASTM A 307 (2000) Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

ASTM A 53 (2001) Standard Specification for Pipe,

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

	Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 563	(2000) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 6/A 6M	(2001) Standard Specification for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C 920	(2001) Standard Specification for Elastomeric Joint Sealants
ASTM D 1784	(1999) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D 2665	(2001) Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E 1	(2001) Standard Specification for ASTM Thermometers
ASTM F 104	(2000) Standard Classification System for Nonmetallic Gasket Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.12	(1998) Cast-Iron Threaded Drainage Fittings
ASME B16.3	(1999) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(1999; R 2001) Process Piping
ASME B36.10M	(2000) Welded and Seamless Wrought Steel Pipe
ASME-17	(2000) Boiler and Pressure Vessel Code;

Section IX, Welding and Brazing
Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS-02 (1990) Welding Handbook; Eighth Ed; Vol
Two - Welding Process

FEDERAL SPECIFICATIONS (FS)

FS FF-S-325 (Int Amd 3) Shield, Expansion; Nail,
Expansion; and Nail, Drive Screw (Devices,
Anchoring, Masonry)

FS HH-I-558 (Rev C) Insulation, Blocks, Boards,
Blankets, Felts, Sleeving (Pipe and Tube
Covering), and Pipe Fitting Covering,
Thermal (Mineral Fiber, Industrial Type)

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports -
Materials, Design and Manufacture

MSS SP-67 (1995) Butterfly Valves

MSS SP-69 (1996) Pipe Hangers and Supports -
Selection and Application

MSS SP-70 (1998) Cast Iron Gate Valves, Flanged and
Threaded Ends

MSS SP-72 (1999) Ball Valves with Flanged or
Butt-Welding Ends for General Service

1.2 GENERAL REQUIREMENTS

Section 15055, "Welding Mechanical," applies to work specified in this
section

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittals," in sufficient detail to show full compliance with the
specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following
items:

Pipe and Fittings

- Piping Specialties
- Valves
- Miscellaneous Materials
- Supporting Elements
- Spare Parts

SD-04 Drawings

As-Built Drawings shall be submitted for Pipes, Valves, and Accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

SD-07 Schedules

Material, Equipment, and Fixture Lists shall be submitted for Pipes, Valves, and Specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. A complete list of construction equipment to be used shall be provided.

SD-09 Reports

Test Reports on the following tests shall be submitted for pipes, valves, and specialties.

- Hydrostatic Tests
- Valve-Operating Tests
- Drainage Tests
- System Operation Tests

SD-18 Records

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Test data shall be legible and of good quality.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Type BCS, Black Carbon Steel (Chilled, Steam, Cooling Tower)

Pipe 1/8 through 10 inches shall be Schedule 40 seamless black carbon

steel, Schedule 80 steam condensate, conforming to ASTM A 53, Type S (seamless).

Fittings 2 inches and under shall be 150-pounds per square inch, gage (psig) working steam pressure wsp banded black malleable iron screwed, conforming to ASTM A 197 and ASME B16.3.

Unions 2 inches and under shall be 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Fittings 2-1/2 inches and over shall be Steel butt weld, conforming to ASTM A 234/A 234M and ASME B16.9 to match pipe wall thickness.

Flanges 2-1/2 inches and over shall be 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

2.1.2 Type BCS-125, (125-psi Service)

Pipe (1/8 through 1-1/2 inches) shall be Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A 53, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Pipe (2 through 8 inches) shall be Schedule 40 steam, Schedule 80 condensate, seamless black carbon steel, conforming to ASTM A 53 Type S (seamless) and ASME B36.10M.

Fittings (2 inches and under) shall be 125-psig wsp banded black malleable iron screwed, conforming to ASTM A 197/197M and ASME B16.3.

Fittings (2-1/2 inches and over) shall be wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9.

Flanges (2-1/2 inches and over) shall be 150-pound, forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to ASTM A 105/A 105M and ASME B16.5.

2.1.3 Condensate Drain

2.1.3.1 Polyvinylchloride (PVC-DWV)

Polyvinylchloride drain, waste, and vent piping-system materials shall be manufactured from Type I normal impact resins in conformance with ASTM D 2665 and with ASME B16.12. Pipe and fitting shall be white and specifically suited for joining socket interfaces into a homogeneous mass by solvent-cement welding.

Fittings shall be molded to produce upon insertion of pipe an interference fit at two-thirds depth of socket. No thread cutting shall be permitted.

Solvent cement joints for pipe and fittings shall be made in accordance with the manufacturer's instruction.

Fittings shall be PVC Schedule 40.

Fittings shall be injection-molded of an improved PVC compound. Fittings shall conform to ASTM D 1784, Cell Classification 12454-B.

Tees and ells shall be side gated.

Fittings shall bear the company's name or trademark, material designation, size, applicable iron pipe size (ips) schedule, and NSF seal of approval.

Threaded nipples shall be standard weight Schedule 80 with molded threads.

2.2 PIPING SPECIALTIES

2.2.1 Dielectric Connections

Dissimilar pipe metals shall be electrically insulated from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.2.2 Pressure Gages

Pressure gages shall conform to ANSI B40.1 and to requirements specified herein. Pressure gages shall be Type I, (for air, steam, and water) Class 1 (pressure) Class 2 (vacuum) Class 3 (pressure/vacuum). Pressure-gage size shall be 3-1/2 inches nominal diameter. Case shall be corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A 6/A 6M, with an ASM No. 4 standard commercial polish or better. Gages shall be equipped with adjustable red marking pointer and damper-screw adjustment in inlet connection. Service-pressure reading shall be at midpoint of gage range. All gages shall be equipped with gage isolators.

2.2.3 Sleeve Couplings

Sleeve couplings for plain-end pipe shall consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

2.2.4 Thermometers

Thermometers shall conform to ASTM E 1. Thermometers shall be industrial pattern Type I, except red Organic-liquid-filled, Class 3 (well-threaded and seal-welded). Thermometers installed 6 feet or higher above the floor shall have an adjustable angle body. Scale shall be not less than 7 inches long. Case face shall be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range shall be 100 percent of normal. Thermometers shall be provided with nonferrous separable wells. Lagging extension to accommodate insulation thickness shall be provided.

2.2.5 Line Strainers, Water Service

Strainers shall be Y-type with removable basket. Strainers in sizes 2-inch ips and smaller shall have screwed ends. In sizes 2-1/2-inch ips and

larger, strainers shall have flanged ends. Body working-pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. All strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer bodies 2-1/2-inches and larger, fitted with bolted-on screen retainers, shall have offset blowdown holes. All strainers larger than 2-1/2-inches shall be fitted with manufacturer's standard ball-type blowdown valve. Body material shall be cast iron conforming to ASTM A 278. Where system material is nonferrous, metal strainer body material shall be nonferrous metal.

Minimum free-hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens shall have perforations not to exceed 0.045-inch. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 316 corrosion-resistant steel.

2.2.6 Line Strainers, Steam Service

Strainers shall be Y-type with removable strainer element.

Body end connections shall be flanged for all valves larger than 2 inches.

Body working steam pressure rating shall be the same as the primary valve rating for system in which strainer is installed, except where welded end materials requirements result in higher pressure ratings. Body shall have integral cast or forged arrows to indicate direction of flow. Strainer bodies shall be provided with blowdown valves that have discharge end plugged with a solid metal plug. Closure assembly shall be made with tetrafluoroethylene tape. Bodies fitted with bolted-on screen retainers shall have offset blowdown holes.

Body materials shall be forged carbon steel conforming to ASTM A 105/A 105M or manufacturer's standard metallurgical equivalents for service pressures of 150-psi wsp and greater, and for lower pressure ratings where welding is required.

Minimum free-hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens shall have perforations not to exceed 0.020 inch or equivalent wire mesh. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 or 316 corrosion-resistant steel and shall be fitted with backup screens where necessary to prevent collapse.

2.3 VALVES

2.3.1 Ball and Butterfly Valves

Ball valves shall conform to MSS SP-72. Valves shall be flanged Grinnell Co. "Hindle" Ultra-Seal, or equal, and shall be rated for service at not less than 175 psig at 200 degrees F. Valve bodies in sizes 2 inches and

smaller shall be screwed-end connection-type constructed of Class A copper alloy. Balls and stems of valves 2 inches and smaller shall be manufacturer's standard with hard chrome plating finish. Valves shall be suitable for flow from either direction and shall seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. All valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

Butterfly valves shall conform to MSS SP-67 and ISO 9001 certification. Valves shall be similar and equal to "Grinnel" Winn high performance valves. Valves shall be wafer type for mounting between specified flanges and shall be rated for 150-psig shutoff and nonshock working pressure. Bodies shall be cast ferrous metal conforming to ASTM A 126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals shall be of the resilient elastomer type designed for field removal and replacement.

2.3.2 Drain, Vent, and Gage Cocks

Drain, vent, and gage cocks shall be lever handle, ground key type, with washer and screw, constructed of polished ASTM B 62 bronze, and rated 125-psi wsp. End connections shall be rated for specified service.

2.3.3 Gate Valves (GAV)

Gate valves 2 inches and smaller shall conform to MSS SP-72. Valves located in equipment rooms, factory-assembled equipment, and where indicated shall be union-ring bonnet, screwed-end type. Packing shall be made of non-asbestos type materials. Valves shall be rising stem type.

Gate valves 2-1/2 inches and larger, shall be Type I, (wedge disk, tapered seats, steam rated); Class I 125-psig steam-working pressure at 353 degrees F saturation); and 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Valves shall be flanged, with bronze trim and outside screw and yoke (OS&Y) construction. Packing shall be made of non-asbestos type materials.

2.3.4 Air Vents

Manual air vents shall be 3/8-inch globe valves.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Bolting

Flange and general purpose bolting shall be hex-head and shall conform to ASTM A 307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts shall conform to ASTM A 563. Square-head bolts and nuts are not acceptable. Threads shall be coarse-thread series.

2.4.2 Elastomer Caulk

Polysulfide- or polyurethane-base elastomer caulking material shall be two-component type, conforming to ASTM C 920.

2.4.3 Flange Gaskets

Compressed non-asbestos sheet, conforming to ASTM F 104, Type 7-P1161A, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 750 degrees F.

2.4.4 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 2 to 3 mils thick shall be used in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval; however, no lead-containing compounds may be used in potable water systems.

2.5 SUPPORTING ELEMENTS

All necessary piping systems and equipment supporting elements shall be provided, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. All supporting elements shall be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Supporting elements shall conform to requirements of ASME B31.3, FS FF-S-325, MSS SP-58, and MSS SP-69 except as noted.

Attachments welded to pipe shall be made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Supporting elements exposed to weather shall be hot-dip galvanized. Materials shall be of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Supporting elements in contact with copper tubing shall be electroplated with copper.

Type designations specified herein are based on MSS SP-58 and MSS SP-69. Masonry anchor group-, type-, and style-combination designations shall be in accordance with FS FF-S-325. Support elements, except for supplementary steel, shall be cataloged, load rated, commercially manufactured products.

2.5.1 Building Structure Attachments

2.5.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to FS FF-S-325 for the following types:

Group I - shield, expansion (lead, bolt and stud anchors)

Group II - shield, expansion (bolt anchors)

Type 2 - machine bolt expansion shield anchors

Class 2 - open-end expansion shield anchors

Style 1 - single-end expansion shield anchors

Style 2 - double-end expansion shield anchors

Group III - shield, expansion (self-drilling
tubular expansion shell bolt anchors)

Group VIII - anchors, expansion (nondrilling)

Cast-in, floor mounted, equipment anchor devices shall provide adjustable positions.

Masonry anchor devices shall be built-in.

Powder-actuated anchoring devices shall not be used to support any mechanical systems components.

2.5.1.2 Beam Clamps

Beam clamps shall be center-loading Type 30.

When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, Type 20 or 27 may be used for piping sizes 2 inches and less and for piping sizes 2 through 10 inches provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, rod diameter shall be determined in accordance with referenced standards.

2.5.1.3 C-Clamps

C-clamps shall not be used.

2.5.1.4 Inserts, Concrete

Concrete inserts shall be Type 18 or 19. When applied to piping in sizes 2 inches ips and larger and where otherwise required by imposed loads, a 1-foot length of 1/2-inch reinforcing rod shall be inserted and wired through wing slots. Proprietary-type continuous inserts may be submitted for approval.

2.5.2 Horizontal Pipe Attachments

2.5.2.1 Single Pipes

Piping in sizes to and including 2-inch ips shall be supported by Type 6 solid malleable iron pipe rings, except that split-band-type rings may be used in sizes up to 1-inch ips.

Piping in sizes through 8-inch ips inclusive shall be supported by Type 1 attachments.

Type 1 and Type 6 assemblies shall be used on vapor-sealed insulated piping and shall have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system 4 inches and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds 1/2 inch, Type 41, 44 through 47, 49 pipe rolls shall be used.

Type 40 shields shall be used on all insulated piping. Area of the supporting surface shall be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges shall be rolled away from the insulation.

Insulated piping without vapor barrier on roll supports shall be provided with Type 39a saddles for pipe sizes to 12-inch ips.

Type 39b saddles shall be used for pipe guiding.

2.5.2.2 Parallel Pipes

Trapeze hangers fabricated from approved structural steel shapes, with U-bolts, shall be used in congested areas and where multiple pipe runs occur. Structural steel shapes shall conform to supplementary steel requirements or be of commercially available, proprietary design, rolled steel.

2.5.3 Vertical Pipe Attachments

Vertical pipe attachments shall be Type 8.

Shop drawing data shall include complete fabrication and attachment details of any spring supports.

2.5.4 Hanger Rods and Fixtures

Only circular cross section rod hangers may be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength shall be used for hangers only where approved.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC S328.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Piping systems shall be fabricated and installed in accordance with ASME B31.3, MSS SP-69, and AWS-02.

Connections between steel piping and copper piping shall be electrically isolated from each other with dielectric couplings (or unions) and/or flanged with gaskets rated for the service.

Final connections to equipment shall be made with unions or flanges provided every 100 feet of straight run. Unions or flanges shall be provided in the line downstream of screwed- and welded-end valves.

All pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with specified joint compound and not more than three threads shall show after joint is made up.

Joint compounds shall be applied to the male thread only and care shall be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems shall be securely supported with due allowance for thrust forces, thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Field welded joints shall conform to the requirements of the AWS-02, ASME B31.3, and ASME-17.

Preheat and postheat treatment of welds shall be done in accordance with ASME-17 and ASME B31.3.

All necessary precautions shall be taken during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Installation shall conform to manufacturer's instructions.

3.2 VALVES

Valves shall be provided in piping mains and all branches and at equipment where indicated and as specified.

Valves shall be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Riser and downcomer drains above piping shutoff valves in piping 2-1/2 inches and larger shall be provided. Shutoff valve body shall be tapped and fitted with a 1/2-inch plugged globe valve.

3.3 SUPPORTING ELEMENTS INSTALLATION

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Supporting elements shall be provided in accordance with the referenced codes and standards.

Piping shall be supported from building structure. No piping shall be supported from roof deck or from other pipe.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there shall be no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements shall be installed at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout, and not over 1 foot from each change in direction of piping.

Load rating for all pipe-hanger supports shall be based on insulated weight of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span shall be reduced proportionately:

PIPE SIZE <u>INCHES</u>	ROD SIZE <u>INCHES</u>	STEEL PIPE <u>FEET</u>	COPPER PIPE <u>FEET</u>
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	12	10
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20
14 to 18	1	20	20
20 and over	1-1/4	20	20

Vibration isolation supports shall be provided where needed.

Vertical risers shall be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers shall be guided for lateral stability. For risers subject to expansion,

only one rigid support shall be provided at a point approximately one-third down from the top. Clamps shall be placed under fittings unless otherwise specified. Carbon-steel pipe shall be supported at each floor and at not more than 15-foot intervals for pipe 2 inches and smaller and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

3.4 PENETRATIONS

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces shall include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings shall be accomplished by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 120 degrees F, by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Foam shall be finished with a rasp. Vapor barrier shall be not less than 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, only mineral wool shall be used and openings shall also be covered with 16-gage sheet metal.

3.5 SLEEVES

Sleeves shall be provided where piping passes through masonry and concrete walls.

Sleeves that extend through walls, and fire barriers shall be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. All other sleeves shall be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide a minimum 3/8-inch clearance. Sleeve size shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to FS HH-I-558, Form B, Type 1 (flexible blanket), Class 8, 451 to 1,000 degrees F. This packing shall be provided wherever the piping passes through firewalls, equipment room walls, connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer calk to a depth of 1/2 inch. All surfaces to be calked shall be oil- and grease-free.

Exterior wall sleeves shall be calked watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.

Sleeve height above roof surface shall be a minimum of 12 and a maximum of 18 inches.

3.6 DISINFECTION

Water piping, including all valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, after which the solution shall contain not less than 10 ppm of available chlorine or the piping shall be reinfected. After successful sterilization, the piping shall be thoroughly flushed before placing into service. Flushing shall be complete when the flush water contains less than 0.5 ppm of available chlorine. Water for disinfected will be furnished by the Government. Contractor shall be responsible for approved disposal of contaminated flush water.

Piping shall be flushed with potable water until visible grease, dirt and other contaminants are removed (visual inspection).

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15055

MECHANICAL WELDING

PART 1 GENERAL

- 1.1 SUMMARY
- 1.2 REFERENCES
- 1.3 SUBMITTALS
- 1.4 QUALIFICATIONS
 - 1.4.1 General
 - 1.4.2 High-Pressure Vessels, High Pressure Piping and Ancillary Fabrication
 - 1.4.3 Low-Pressure Vessels and Low-Pressure Piping
 - 1.4.3.1 Plumbing
 - 1.4.3.2 Low-Pressure Piping

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

- 3.1 CONSTRUCTION
 - 3.1.1 High Pressure
 - 3.1.2 Piping
 - 3.1.2.1 Low Pressure
 - 3.1.3 Ancillary Fabrication
- 3.2 ENVIRONMENTAL AND HEAT CONTROLS
 - 3.2.1 Preheat
 - 3.2.1.1 Materials For Which No Preheat Is Required By Code
 - 3.2.1.2 Materials For Which Preheat Is Required By Code
 - 3.2.2 Interpass Temperature
 - 3.2.3 Post Weld Heat Treatment
- 3.3 INSPECTION/NONDESTRUCTIVE EXAMINATION (NDE)
 - 3.3.1 General
 - 3.3.2 Piping and Ancillary Fabrication
 - 3.3.2.1 General
 - 3.3.3 Piping
 - 3.3.3.1 High Pressure
 - 3.3.4 Piping
 - 3.3.4.1 Low Pressure
 - 3.3.5 Ancillary Fabrication
- 3.4 PROTECTION OF ADJACENT MATERIALS

-- End of Section Table of Contents --

SECTION 15055

MECHANICAL WELDING

PART 1 GENERAL

1.1 SUMMARY

This specification contains the minimum requirements for qualifying welding procedures, welders, and welding operators and for effecting and inspecting welds joints, in mechanical fabrications of carbon steel and austenitic stainless steel materials and any other metals used in pressure containing systems.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1 (1998) Power Piping

ASME B31.3 (1999; R 2001) Process Piping

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/AWS D1.1 (2000) Structural Welding Code - Steel

LANGLEY RESEARCH CENTER (LaRC)

LAPG 1710.41 (March 2000) Evaluation of Socket and Branch Connections

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-04 Drawings

The Contractor shall submit an isometric arrangement drawing (weld map) of the pressure piping system as installed. The drawing shall include system components, numbered pressure piping welds, offsets, bends, supports, and all other specific elements which represent the as-built configuration. Unique, sequential, LaRC weld numbers will be supplied to the Contractor to identify pressure piping welds. Attachment (1) depicts the isometric drawing format to be used in the development of the weld map drawing submittal. A title block shall be included. Attachment

(2), is a blank isometric sheet.

SD-08 Statements

Within fifteen calendar days after receipt of Notice to Proceed, the Contractor shall submit, for approval to the Contracting Officer, the following items:

Welding Procedure Specifications (WPS), two copies

Certified Procedure Qualification Records (PQR), two copies

Certified Welder Performance Qualifications (WPQ), two copies

SD-09 Reports

Visual Inspection Report

Radiographs and reader sheet reports shall be submitted for retention by the Government within 7 calendar days of the acceptance of welds.

1.4 QUALIFICATIONS

1.4.1 General

The Contractor shall qualify the welding procedures and welders by tests prescribed in the applicable code or specification, notwithstanding the fact that the code or specification may allow pre-qualified procedures.

High pressure is defined herein as 125 psig and above. Low pressure is defined as below 125 psig.

1.4.2 High-Pressure Vessels, High Pressure Piping and Ancillary Fabrication

The welding qualification documents WPS, PQR and WPQ shall be in accordance with Section IX of the ASME Boiler and Pressure Vessel (BPV) Code. Ancillary fabrication performed in conjunction with mechanical piping and pressure vessels shall be limited to pipe supports, brackets, and mounts related to the piping and/or vessel installation. The construction of steel building structures shall conform to the Structural Steel Welding Code, ANSI/AWS D1.1.

1.4.3 Low-Pressure Vessels and Low-Pressure Piping

1.4.3.1 Plumbing

Plumbing work shall be performed by a Virginia state licensed plumber.

1.4.3.2 Low-Pressure Piping

The qualification documents, WPS, PQR and WPQ for other low-pressure piping shall be in accordance with Section IX of the ASME BPV Code.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 High Pressure

All seam welded pipe and fittings shall be 100 percent radiographically inspected to ASME B31.3, Severe Cyclic Service.

- A - Steam Piping: The Contractor shall fabricate, assemble, and weld (but not inspect) in accordance with the ASME B31.1, Power Piping Code, the seven (7) Piping Fabrication Institute's references listed and companion Codes, with the following exceptions:

The Contractor shall use only steel components in these piping systems. Joints in the high pressure piping systems shall utilize either consummable inserts or open butt welding techniques.

3.1.2 Piping

3.1.2.1 Low Pressure

- A - Low Pressure Piping: The Contractor shall fabricate, assemble, weld/solder in accordance with the ASME B31.1, Power Piping Code requirements.
- B - Plumbing: The Contractor shall fabricate, assemble, weld/solder in accordance with the BOCA Basic Plumbing Code requirements.

3.1.3 Ancillary Fabrication

Welded ancillary components shall be fabricated, assembled and welded in accordance with ANSI/AWS D1.1, Structural Steel Welding Code.

3.2 ENVIRONMENTAL AND HEAT CONTROLS

3.2.1 Preheat

3.2.1.1 Materials For Which No Preheat Is Required By Code

The Contractor shall not weld when rain or snow is falling on the surfaces of the parts in the area to be welded, or when they are wet from rain, snow or ice. When adverse conditions exist, the welder and work area shall be properly shielded and the material to be welded shall be above 50 degrees F. When the material is below 50 degrees F and/or the thickness is in excess of one inch, the Contractor shall heat the joint to a temperature that is warm to the hand, approximately 100 degrees F.

The Contractor shall preheat all joints displaying moisture until the moisture is evaporated.

3.2.1.2 Materials For Which Preheat Is Required By Code

The Contractor shall preheat the material to be welded to the temperature specified in the applicable code.

3.2.2 Interpass Temperature

Interpass temperature shall not fall below the preheat temperature. Temperature may be monitored at the start of each pass, one inch adjacent to the weld joint. Maximum interpass temperature shall not exceed the temperature limits specified in the NASA approved weld procedure.

3.2.3 Post Weld Heat Treatment

Weldments shall be heat treated as required by the applicable NASA approved, Code qualified/certified, welding documentation, WPS and PQR.

3.3 INSPECTION/NONDESTRUCTIVE EXAMINATION (NDE)

Nondestructive Examination Requirements - The Contractor shall radiographically inspect welded joints in pipes, and fittings as specified herein.

When heat treatment or stress relieving is required, the Contractor shall radiographically inspect the joints in accordance with the applicable ASME codes. In addition, the weld joints and their heat affected zone shall be MT or PT examined after heat treatment.

3.3.1 General

The Contractor shall perform the necessary fabrication/erection inspection prior to assembly, during assembly, during welding and after welding, to ensure that materials and workmanship meet the minimum requirements of the contract documents.

Inspector's qualifications shall be in accordance with AWS and/or ASME codes.

The Contractor shall mark each pressure containing weld or adjacent area with a low stress zero symbol and direction indicator, for radiographic orientation.

The Contractor shall assign each qualified welder an identification symbol. The Contractor shall mark each pressure containing weld or adjacent area, with the low stress identification symbol of the welder. In lieu of marking, appropriate documentation shall be filed, which includes the information required in items A through F below. All inspection reports shall be submitted for retention by the Government, within 7 calendar days of the inspection.

Where radiography is specified, each radiograph shall, as a minimum, have the following additional information permanently included in the image;

A - (Unique) LaRC supplied Weld No. detailed on the Isometric Drawings (including repair cycle no.)

B - LaRC Drawing No.

C - LaRC View No.

D - Welder I.D., Stamp No. or Identification Symbol

E - Date

F - LaRC Contract No.

With the exception of Code stamped pressure vessel welds, the Contracting Officer will perform final interpretation and acceptance of all radiographs of welded joints.

The Contracting Officer will perform the final acceptance of all welded joints.

Prior to the Contracting Officer's inspection, the Contractor shall remove all slag, scale and spatter from all welds. The procedure employed shall not produce notches in either the weld metal or adjacent base metal.

When less than 100 percent radiographic examination (RT) is specified, the locations of the weld joint shall be selected or approved by the Inspector for each welder's work.

When examination by (RT) reveals a defect, the defective weld shall be repaired or replaced to meet specifications. Two additional samples of the same kind of weld made by the same welder shall be examined by the same method, at no additional cost to the Government. If the examination of the two additional weld joints reveals any defect, all welds made by that welder shall be fully examined and repaired or replaced, as necessary to meet the requirements of the specification and the applicable code, at no additional cost to the Government.

The Contractor shall repair and reinspect all unacceptable welds at no additional cost to the Government.

After weld joints have been satisfactorily completed by the Contractor and accepted by the Contracting Officer, the Contractor shall clean the joint area to a bright, unpitted, and unscarred surface. The base metal and weld thicknesses shall not be reduced below applicable code allowable limits. The surface shall then be protected in accordance with the applicable contract documents specifying coatings or specific surface conditions.

The Contractor shall submit all accepted radiographs and reader sheet reports to the Government for retention.

3.3.2 Piping and Ancillary Fabrication

3.3.2.1 General

All Nondestructive Examination (NDE) shall be performed in accordance with the requirements of Section V of the ASME Boiler and Pressure Vessel Code,

for all new and repaired piping, and minor structural fabrication, except for branch connection and socket welds.

All branch connections and socket welds shall be inspected in accordance with LAPG 1710.41, Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds.

Radiographic inspection of piping girth butt welds shall utilize tangential techniques only. Elliptical techniques shall be avoided.

3.3.3 Piping

3.3.3.1 High Pressure

A. General

All butt, branch-connections and socket welds shall be 100 percent radiographically inspected.

B. Acceptance Requirements

- (1) - All butt welds in steam piping systems shall meet the acceptance requirements of the ASME B31.1, Power Piping Code.
- (2) - All butt welds in non-steam piping systems shall meet the acceptance requirements of the ASME B31.3, Process Piping Code for Severe Cyclic Service.
- (3) - All socket and branch connection welds shall meet the acceptance requirements of LAPG 1710.41, "Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds".

3.3.4 Piping

3.3.4.1 Low Pressure

A. Acceptance Requirements

Low pressure piping systems shall meet the acceptance requirements of the ASME B31.1, Power Piping Code.

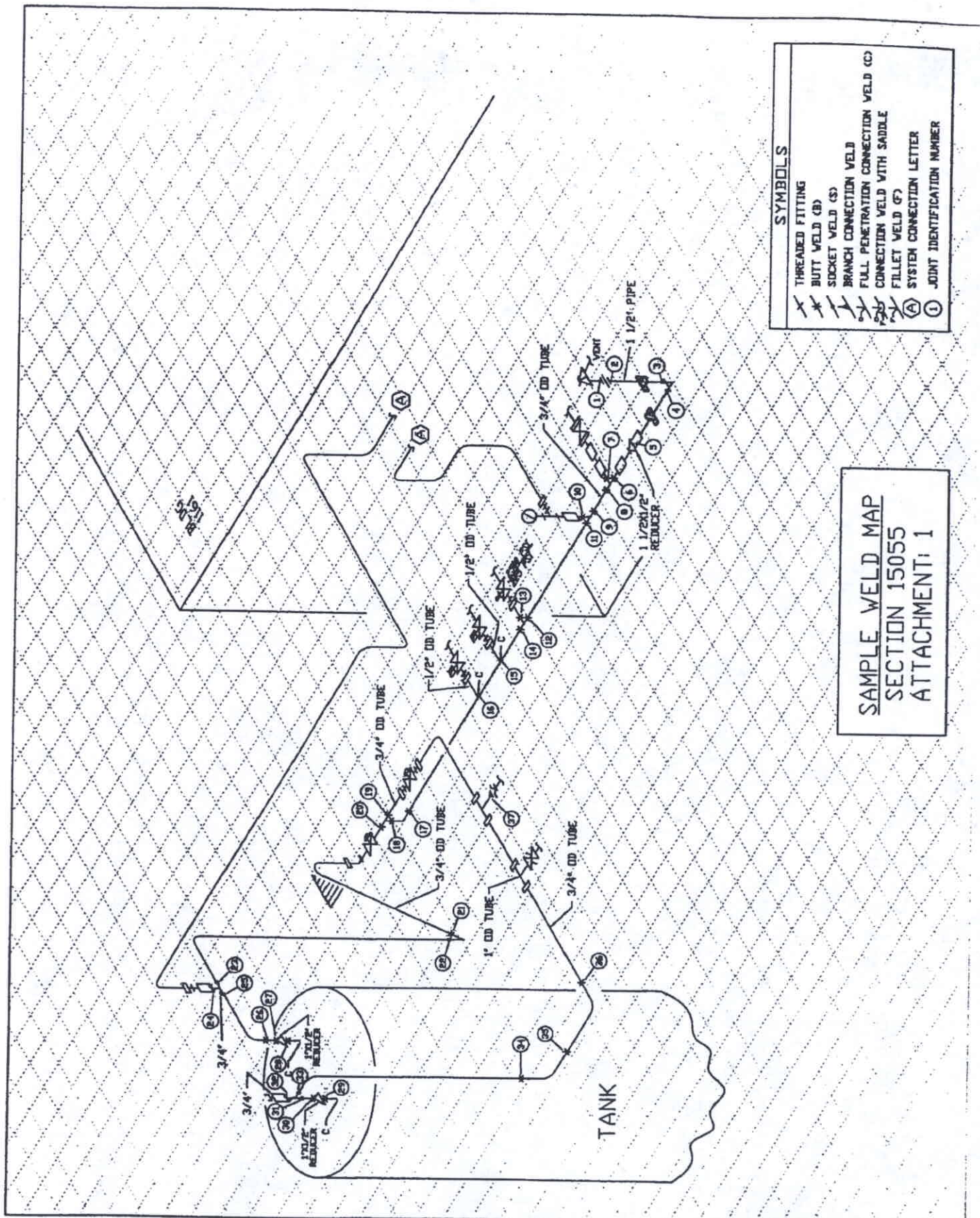
3.3.5 Ancillary Fabrication

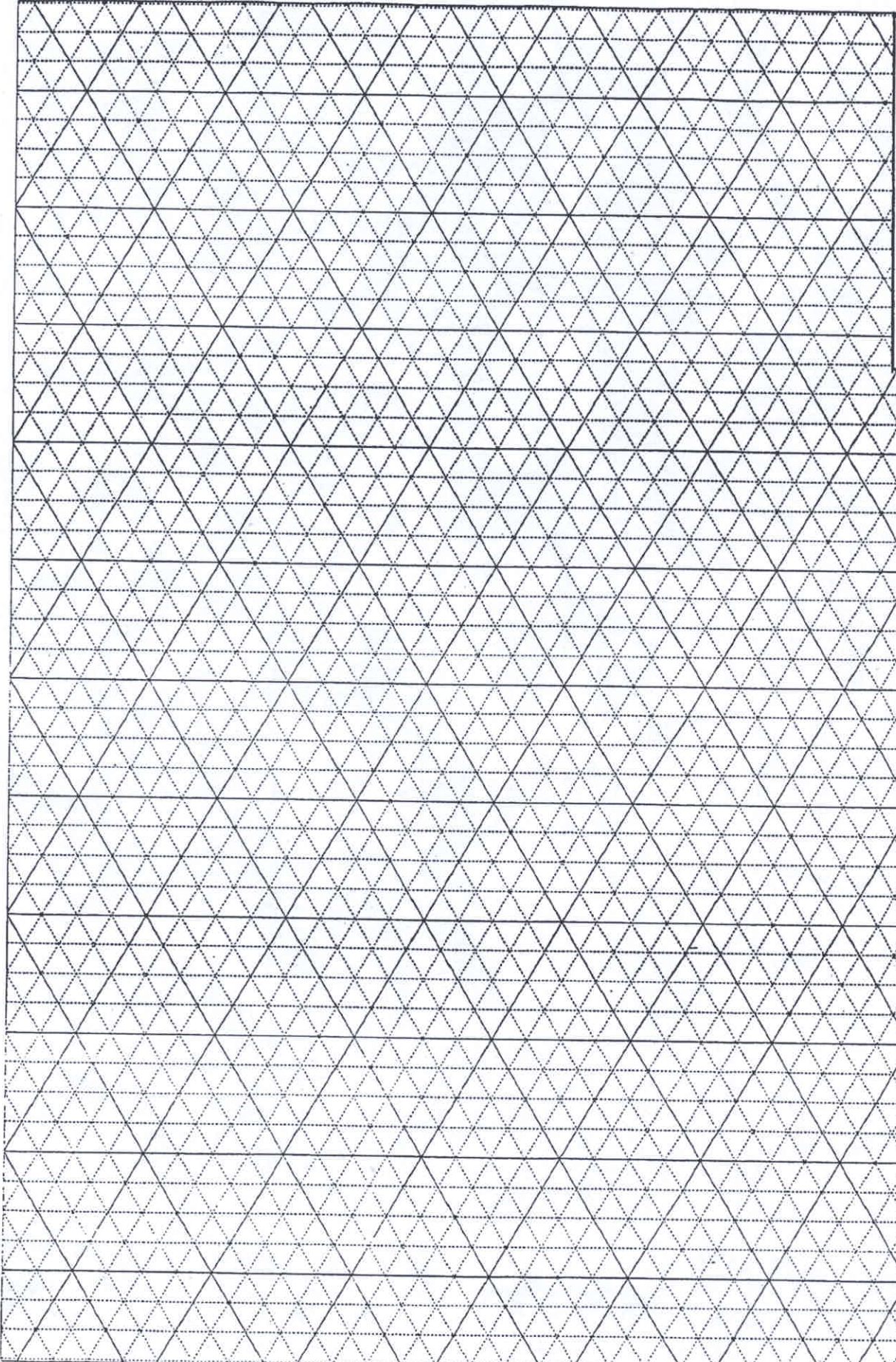
All ancillary component welds shall be visually inspected, in accordance with ASME Section V, Nondestructive Examination Guidelines. All ancillary fabrication welds shall satisfy the acceptance criteria of applicable pressure vessel and/or piping codes.

3.4 PROTECTION OF ADJACENT MATERIALS

The Contractor shall sufficiently protect machinery, materials, floor, and surfaces adjacent to the welding/brazing/soldering operations, to prevent any damage from these operations.

-- End of Section --



	TITLE	BLOCK
	BUILDING NUMBER	
	SYSTEM NAME	
	CONTRACT NUMBER	
ATTACHMENT: 2 SECTION 15055		

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15080

MECHANICAL INSULATION

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Adhesives
 - 2.1.1.1 Cloth Adhesives
 - 2.1.1.2 Vapor-Barrier Material Adhesives
 - 2.1.1.3 Cellular Elastomer Insulation Adhesive
 - 2.1.2 Coatings
 - 2.1.2.1 Indoor Vapor-Barrier Finishing
 - 2.1.2.2 Outdoor and Indoor Nonvapor-Barrier Finishing
 - 2.1.2.3 Coating Color
 - 2.1.2.4 Mineral Fiber
 - 2.1.2.5 Flexible Blankets
 - 2.1.2.6 Glass Cloth Jackets
 - 2.1.2.7 3-Ply Laminate Jackets
 - 2.1.3 Tape
- 2.2 PIPING INSULATION AND JACKET
 - 2.2.1 Fiberglass Preformed Pipe Insulation
 - 2.2.2 Cellular Elastomer
 - 2.2.3 Pipe Jacket
 - 2.2.3.1 PVC Jackets
- 2.3 PIPING INSULATION AND JACKET
 - 2.3.1 Cellular Elastomer
- 2.4 DUCT INSULATION AND JACKET
 - 2.4.1 Rigid Fiberglass Duct Insulation
 - 2.4.2 Glass Cloth

PART 3 EXECUTION

- 3.1 INSTALLATION OF MECHANICAL INSULATION
 - 3.1.1 Piping Insulation
- 3.2 DUCT INSULATION
 - 3.2.1 Rigid Insulation
 - 3.2.2 Duct Sleeves and Pipe Sleeves
 - 3.2.3 Access Plates and Doors

- 3.2.4 Insulation Finishes and Joint Sealing
- 3.2.5 Moisture Seal
- 3.3 GLASS-CLOTH JACKETING
- 3.4 CHILLER INSULATION REQUIRED
- 3.5 FIELD INSPECTIONS

-- End of Section Table of Contents --

SECTION 15080

MECHANICAL INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1136	(1995) Flexible, Low permeance Vapor Retarders for Thermal Insulation
ASTM C 547	(1995) Mineral Fiber Preformed Pipe Insulation
ASTM C 553	(2000) Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 592	(2000) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 916	(1985; R 2001) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C 921	(1989; R 1996) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D 579	(1990) Standard Specification for Greige Woven Glass Fabrics
ASTM E 84	(1995) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000e1) Standard Test Methods for Water Vapor Transmission of Materials

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AMS 3779/1A	(1990) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant, Aluminum Foil/Glass Cloth
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SAE AMS 3779A

(1990) Tape Adhesive, Pressure Sensitive
Thermal Radiation Resistant

1.2 SYSTEM DESCRIPTION

Provide field-applied mechanical insulation for mechanical systems and existing insulated mechanical systems affected by the Contractors operations. Mechanical systems include heating, ventilating, and cooling equipment, ducts, and piping which is located within, on, under, and adjacent to buildings; and for plumbing systems. Obtain Contracting Officer's approval of each system before applying field-applied insulation. Provide new asbestos-free insulation materials.

Nominal duct sizes are internal dimensions.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturers Catalog Data shall be submitted for the following items:

Piping Insulation and Jacket
Duct Insulation and Jacket

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Cloth Adhesives

Adhesives for adhering, sizing, and finishing lagging cloth, canvas, and open-weave glass cloth shall be a pigmented polyvinyl acetate emulsion and shall conform to the requirements of ASTM C 916, Type I.

2.1.1.2 Vapor-Barrier Material Adhesives

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, shall be solvent-base, synthetic-rubber type and shall conform to the requirements of ASTM C 916, Type I, for attaching fibrous-glass insulation to metal surfaces. Solvent shall be nonflammable.

2.1.1.3 Cellular Elastomer Insulation Adhesive

Adhesive for cellular elastomer insulation shall be a solvent cutback chloroprene elastomer conforming to ASTM C 916, Type I, and shall be of a type approved by the manufacturer of the cellular elastomer for the intended use.

2.1.2 Coatings

2.1.2.1 Indoor Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be a pigmented resin and solvent compound and shall conform to ASTM C 1136, Type II.

2.1.2.2 Outdoor and Indoor Nonvapor-Barrier Finishing

Coatings for outdoor and indoor nonvapor-barrier finishing of insulation surfaces shall be pigmented polymer-emulsion type recommended by the insulation material manufacturer for the surface to be coated and shall be applied to specified dry-film thickness.

2.1.2.3 Coating Color

Coating color shall be white.

2.1.2.4 Mineral Fiber

Mineral fiber shall conform to ASTM C 592, ASTM C 553, ASTM C 547, shall be suitable for surface temperatures up to 370 degrees F, and shall be of not less than 4-pound per cubic foot density. Thermal conductivity shall be not greater than 0.26 Btu per hour per square foot square per degree F at 150 degrees F mean.

2.1.2.5 Flexible Blankets

Flexible blankets shall be blankets and felts for use at temperatures up to and including 350 degrees F minimum 1 pound per cubic foot density. Thermal conductivity shall be not greater than 0.26 Btu per hour per square foot per degree F at 75 degrees F mean.

2.1.2.6 Glass Cloth Jackets

Glass cloth shall be plain-weave glass cloth conforming to ASTM D 579, Style 141 and shall weigh not less than 7.23 ounces per square yard before sizing. Cloth shall be factory applied wherever possible.

Glass reinforcing cloth shall be a leno weave, 26-end and 12-pick thread conservation, with a warp and fill tensile strength of 45 and 30 pounds per inch of width, respectively, and with a weight of not less than 1.5 ounces per square yard. At the Contractor's option, Style 191 leno-weave glass cloth conforming to ASTM D 579 may be provided.

2.1.2.7 3-Ply Laminate Jackets

Jacketing shall be a 3-ply laminate of 35-pound per 100 square foot white-bleached kraft, bonded to not less than 0.0007-inch thick aluminum foil and reinforced with glass fiber.

Water-vapor permeance rating of the composite shall be 0.02 perm or grain per hour per square foot, per inch of mercury pressure differential, determined in accordance with ASTM E 96.

2.1.3 Tape

Glass lagging shall be a knitted elastic cloth specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and shall produce a smooth, tight, wrinkle-free surface. Tape shall conform to requirements of SAE AMS 3779A, SAE AMS 3779/1A, ASTM D 579, and ASTM C 921, and shall weigh not less than 10 ounces per square yard.

2.2 PIPING INSULATION AND JACKET

2.2.1 Fiberglass Preformed Pipe Insulation

Steam and condensate insulation shall be preformed fiberglass with all service jacket.

Fiberglass shall conform to ASTM C 547, shall be suitable for surface temperatures up to 370 degrees F. Thermal conductivity shall be not greater than 0.26 Btu per hour per square foot per degrees F at 150 degrees F mean. Jacket shall be high density white kraft paper bonded to aluminum foil and reinforced with glass fibers.

2.2.2 Cellular Elastomer

Cellular elastomer shall have a minimum thermal conductivity less than 0.27 BTU inch/HR/square foot/degree F/inch.

2.2.3 Pipe Jacket

2.2.3.1 PVC Jackets

Polyvinylchloride (PVC) shall be a 0.010-inch thick, factory-premolded, one-piece fitting or pipe-barrel sheeting vapor-barrier jacketing. Material shall be self-extinguishing, and shall conform to ASTM D 1927, Composition A polyvinylchloride, Type II, high-impact strength, moderate chemical resistance. Permeability rating shall be 0.01 grain per hour per square foot per inch of mercury pressure difference, determined in accordance with ASTM E 96. Vapor-barrier joint adhesive shall be the manufacturer's standard solvent-weld type. Johns Manville Zeston 2000 PVC covering, or equal; installed per manufacturer's requirements.

2.3 PIPING INSULATION AND JACKET

2.3.1 Cellular Elastomer

Steam and condensate insulation shall be preformed fiberglass with ASJ Kraft jacket bonded to aluminum foil and reinforced with glass fiber, K

less than 26 Btu/hr/ft²F.

Cellular elastomer shall have a minimum thermal conductivity less than 0.27 BTU inch/HR/square foot/degree F/inch.

All pipe lower than 7 feet, or as required by insulation schedule on drawings, shall have PVC pipe jacketing. PVC pipe jacketing shall be industry standard for this application. Johns Manville Zeston 2000 PVC covering, or equal. This product shall be installed according to manufacturer's recommendations.

2.4 DUCT INSULATION AND JACKET

All duct located in non concealed spaces shall have 1-1/2 inch, 3 pound per cubic foot, rigid fiberglass board insulation wrapped with glass cloth jacket and vapor barrier mastic coating.

2.4.1 Rigid Fiberglass Duct Insulation

Rigid boards shall be Form A, blocks and boards, Class 1, for use at temperatures up to 400 degrees F, nonloadbearing, minimum 3 pounds per cubic foot density. Thermal conductivity shall be not greater than .26 BTU inch per hour per degrees F at 150 degrees F.

2.4.2 Glass Cloth

Glass cloth shall be plain weave conforming to ASTM D 579, Style 141, and shall weigh not less than 7.23 ounces per square yard.

All pipe lower than 7 feet, or as required by insulation schedule on drawings, shall have PVC pipe jacketing. PVC pipe jacketing shall be industry standard for this application. Johns Manville Zeston 2000 PVC covering, or equal. This product shall be installed according to manufacturer's recommendations.

PART 3 EXECUTION

3.1 INSTALLATION OF MECHANICAL INSULATION

Clean exterior of mechanical systems prior to the application of field-applied insulation. Install field-applied insulation in accordance with the manufacturer's recommendations and as specified herein. The completed installation shall have a fire hazard rating in accordance with ASTM E 84; flame-spread rating shall not exceed 25 and smoke developed rating shall not exceed 50 except as specified herein; smoke developed rating shall not exceed 150 for polyurethane insulations. Insulation shall be clean and dry when installed and prior to the application of jackets and coatings. Do not use short pieces of insulation materials where a full length section will fit. Provide insulation materials and jackets with smooth and even surfaces, with jackets drawn tight, and smoothly secured on longitudinal laps and end laps. Insulate fittings and piping accessories with premolded, precut, or field fabricated insulation of the same material and thickness as the adjoining pipe insulation. Provide unions, flanges, and piping accessories with readily removable sections of insulation and

jacket. Provide insulation continuous through pipe hangers, pipe supports, pipe sleeves, wall openings, and ceiling openings, except at fire dampers in duct systems. Provide a complete moisture and vapor seal wherever insulation terminates against hangers, anchors, and other projections through insulation on cold surfaces; fill joints, breaks, punctures, and voids with vapor barrier compound and cover with vapor sealed material. Do not conceal equipment nameplates. Cover ends of exposed insulation with waterproof mastic.

3.1.1 Piping Insulation

Provide factory preformed pipe insulation. For insulation protection shields; provide rigid pipe insulation of the same thickness as adjacent pipe insulation having a minimum compressive strength of 35 psi, or provide hardwood plugs having a minimum of one square inch bearing surface with the wood grain perpendicular to the pipe, between the insulation protection shields and the pipe. Insulation having a minimum density of 7 pcf may be provided between the insulation protection shields and the pipe for piping 2 inches and smaller.

All cellular elastomer insulation exposed to ultraviolet radiation shall have two coats of polyvinylchloride lacquer as approved by the manufacturer.

3.2 DUCT INSULATION

Insulation shall be continuous through sleeves, wall and ceiling openings, except at fire dampers in duct systems. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at manufacturer's recommended coverage per gallon.

3.2.1 Rigid Insulation

Secure rigid insulation by impaling over pins or anchors located not more than 3 inches from joint edges of boards, spaced not more than 12 inches o.c. and secure with washers and clips. Spot weld anchor pins or attach with a waterproof adhesive especially designed for use on metal surfaces. Apply insulation with joints tightly butted. Each pin or anchor shall be capable of supporting a 20 pound load. Cut off protruding ends of pins, after clips are sealed with coating compound for inside work or manufacturer's recommended weatherproof coating for outside work, and reinforce with open weave glass membrane.

3.2.2 Duct Sleeves and Pipe Sleeves

Insulation shall be continuous through sleeves, wall and ceiling openings, except at fire dampers in duct systems. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at manufacturer's recommended coverage per gallon.

3.2.3 Access Plates and Doors

On acoustically lined ducts, plenums, and casings, provide insulation on access plates and doors. On externally insulated ducts, plenums, and casings, bevel insulation around access plates and doors.

3.2.4 Insulation Finishes and Joint Sealing

Fill breaks, punctures, and voids with vapor barrier coating compound for inside work or manufacturer's recommended weatherproof coating. Vapor seal joints by embedding a single layer of 3 inch wide open weave glass membrane, maximum 20 by 20 mesh per linear one inch between two 1/16 inch wet film thickness coats of vapor barrier coating compound. Draw glass fabric smooth and tight with a 1 1/2 inch overlap. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill voids in insulation with vapor barrier coating. Brush a coat of vapor barrier coating where required on HVAC ducts. Provide vapor barrier jacket continuous across seams, reinforcements, and projections. Where height of projections is greater than insulation thickness, carry insulation and jacket over projection. For all duct running through corridor between old section and new section, provide insulation with two coats of fire resistant adhesive with glass fabric mesh embedded between coats.

3.2.5 Moisture Seal

Provide a vapor (moisture) seal where insulation terminates against metal hangers, anchors and other projections through insulation on surfaces for which a vapor seal is specified. Keep insulation dry during application of finish. Bevel and seal edges of exposed insulation.

3.3 GLASS-CLOTH JACKETING

Glass-cloth jacketing shall be applied over the insulation and securely cemented in place with vapor-barrier adhesive. Corner angles shall be not less than .002 inch galvanized sheet metal with leg dimensions equal to thickness of insulation. Glass cloth embedded in the adhesive shall be pulled tight and wrinkle-free and shall lap seams not less than 4 inches.

Insulation shall be finished with two coats of vapor-barrier mastic coating. Coating color shall be white. Jacket shall be weathertight.

3.4 CHILLER INSULATION REQUIRED

Insulation is required on hot areas to protect operating and service personnel and on cold areas to prevent sweating. All insulation is installed in the field.

Insulation for the hot insulation area should be 3-inch No. 8 density mineral wool applied over stud pins. Stud pins shall be applied using high temperature epoxy, or as required by chiller manufacturer's written instructions. Insulation shall be applied on the generator, high temperature heat exchanger and associated piping. Refer to chiller manufacturer's installation guide. Provide glass cloth/mastic, or 3-ply laminate jacketing over all mineral wool insulation on flat surfaces. Provide fiberglass preformed pipe insulation with jacket on piping at all locations recommended by chiller manufacturer's written instructions.

Insulation for cold insulation area should be 3/4-inch Armaflex, or equal, and should be applied to evaporator waterboxes, refrigerant storage tank,

refrigerant pump and refrigerant piping.

Apply all insulation per chiller manufacturer's written instructions, and those herein.

3.5 FIELD INSPECTIONS

The Contractor shall visually inspect the insulation installation of all mechanical systems to ensure that materials conform to requirements specified herein.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15125

STEAM TRAPS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 MATERIALS
- 2.2 TRAP APPLICATION
- 2.3 TRAP-SIZING CRITERIA
- 2.4 TRAP TYPE, CONSTRUCTION, AND MATERIALS
 - 2.4.1 Type F&T

PART 3 EXECUTION

- 3.1 TRAP INSTALLATION
- 3.2 COMPONENT INSTALLATION

-- End of Section Table of Contents --

SECTION 15125

STEAM TRAPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105/A 105M	(2001) Standard Specification for Forgings, Carbon Steel, for Piping Components
ASTM A 216/A 216M	(1993; R 1998) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A 278	(2001) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degrees F

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for Steam Traps.

PART 2 PRODUCTS

2.1 MATERIALS

Traps exposed to weather shall be freezeproof.

2.2 TRAP APPLICATION

SERVICE

TRAP TYPE

Drip-leg at chiller steam generator input

Type F&T, float and
thermostatic

2.3 TRAP-SIZING CRITERIA

Trap shall be sized to provide an actual capacity, under normal operating conditions, of three times normal condensing rate.

2.4 TRAP TYPE, CONSTRUCTION, AND MATERIALS

Trap bodies and components shall have a primary working steam pressure (wsp)-rating equal to or in excess of the maximum wsp of the steam system to which applied.

Trap bodies for pressures 125-psi wsp and under shall be cast iron in accordance with ASTM A 278, Class 30.

Welded end connection trap bodies shall be cast steel in accordance with ASTM A 216/A 216M, Grade WCB or forged carbon steel in accordance with ASTM A 105/A 105M.

Traps shall have permanent external identification of service rating and orifice size.

2.4.1 Type F&T

Float and thermostatic traps shall have AISI 300 series corrosion-resistant steel, heliarc-welded floats and operating mechanisms, and hardened, 13 percent chrome corrosion-resistant steel seats and valves.

Thermostatic elements shall be balanced pressure type, with corrosion-resistant alloy bellows charged with a fluid that will provide most rapid response to changes in temperature.

Bellows shall be suitable for service with condensate having a pH of 6.0.

Traps shall be designed to permit removal and replacement of all operating and wearing parts without disturbing piping connections to trap body.

Bellows shall be designed to permit removal while hot without overexpansion and shall be shielded from direct blast of steam and condensate.

Bodies shall be fitted with drain plug.

PART 3 EXECUTION

3.1 TRAP INSTALLATION

Traps shall be installed in accordance with the manufacturer's instructions.

3.2 COMPONENT INSTALLATION

Trap components shall be installed in accordance with the manufacturer's instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15626

CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 CENTRIFUGAL WATER-CHILLER PACKAGE
- 2.2 COMPRESSOR
- 2.3 CONDENSER
- 2.4 COOLER (REFRIGERANT EVAPORATOR)
- 2.5 PURGE SYSTEM
- 2.6 PUMP-OUT SYSTEM
- 2.7 CONTROL AND CONTROL PANELS
- 2.8 MOTORS
- 2.9 INSULATION
- 2.10 SPECIAL TOOLS
- 2.11 STARTER
- 2.12 VERIFICATION OF CAPACITY AND EFFICIENCY
- 2.13 SOUND
- 2.14 REFRIGERANT MONITOR
- 2.15 Exhaust Fan: EX-1

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 MANUFACTURER'S REPRESENTATIVE
- 3.3 REFRIGERANT AND OIL CHARGE
- 3.4 FIELD TESTING

-- End of Section Table of Contents --

SECTION 15626

CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 480 (1995) Refrigerant-Cooled Liquid Coolers, Remote Type

ARI 520 (1997) Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units

ARI-STD-575 (1994) Method of Measuring Machinery Sound Within an Equipment Space

ARI 550/590 (1998) Centrifugal and Rotary Screw Water-Chilling Packages

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 (2001) Safety Standard for Refrigeration Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-16 (1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Design Analysis and Calculations shall be submitted for Centrifugal Chillers indicating the manufacturer's recommended horsepower ratings, rotational speeds, and piston speeds.

Manufacturer's Catalog Data shall be submitted for the following items:

- Centrifugal Water Chiller
- Purge System
- Motors
- Control and Control Panels
- Refrigerant Monitor
- Insulation
- Vibration Isolation
- Refrigerant Monitoring Exhaust Fan

SD-04 Drawings

Connection Diagrams shall be submitted indicating the relations and connections of the following items. The drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

- Centrifugal Water Chillers
- Purge System
- Motors
- Control and Control Panels

SD-09 Reports

Test Reports for chiller unit shall be submitted indicating the results of Performance Tests performed in accordance with the paragraphs entitled, "Field Testing" and "Sound Pressure Test" of this section.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Centrifugal Chiller System. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 3/8-inch holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

The Contractor shall provide classroom and field instructions in operation and maintenance of systems equipment where required by

the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory trained personnel or qualified representative. The Contracting Officer shall be given seven calendar days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids, shall be made available to the Contracting Officer.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

PART 2 PRODUCTS

2.1 CENTRIFUGAL WATER-CHILLER PACKAGE

Centrifugal water-chiller assembly shall be packaged and self-contained, and shall include compressor-condenser, cooler (refrigerant evaporator) accessories, control panel, and intercomponent piping and wiring ready for field-terminal connections.

Unit shall conform to the applicable requirements of ARI 550/590, ARI 480, and specified requirements. Energy efficiency rating shall be as shown.

2.2 COMPRESSOR

Compressor shall be single or multistage, direct- or gear-driven centrifugal type, with hermetically sealed, compressor-motor assembly. Motor windings shall be refrigerant cooled. Open compressor-motor assemblies are not acceptable. Rotor shall be statically and dynamically balanced at the factory. Amplitude of internally excited vibration shall not exceed one mil peak-to-peak when measured with a vibrometer at the compressor end of the motor. Shaft main bearings shall be replaceable sleeve-insert type.

Lubrication system shall be of the forced-feed type with oil sump, hermetically sealed motor-driven positive displacement pump, oil filter, and strainer. Oil temperature shall be thermostatically controlled. A mechanically operated oil supply shall be provided to the bearings during spin down in event of power interruption. A differential oil-pressure cutout shall be interlocked with starting equipment and shall allow the compressor to operate only when the required oil pressure is available at the bearings.

Compressor shall be provided with temperature-actuated capacity reduction and shall be of the multiple radial blade or butterfly-damper type to provide automatic capacity regulation from 100 percent to 10 percent of capacity. Automatic hot-gas bypass shall be provided if required to maintain stable operation. The control system shall include automatic stopping, when load falls below 10 percent capacity point, and automatic unloaded restarting on load demand. Capacity modulation shall be controlled by the temperature of the water leaving the cooler. The unit controller shall be able to maintain leaving-water temperature at plus or

minus 0.5 degree F of the set point. Compressor shall operate with refrigerant HCFC-123, HCFC-22, or HFC-134a.

2.3 CONDENSER

Condenser shall be of the shell-and-tube cleanable-type construction. Condenser shall comply with ASME-16 regarding quality of materials used, methods of construction, design of components, and testing of materials, assemblies, connections, and appurtenances. Minimum water-side working pressure shall be 150 psig, and minimum refrigerant-side working pressure shall be saturation pressure of refrigerant used at 85 degrees F. Spaces not subject to ASME code due to size or other limitations shall be pneumatically tested at 1-1/2 times working pressure or 45 psig, whichever is greater.

Tubes shall be seamless copper tubing with integral fins and shall be individually removable from either end of shell. Tubes shall be rolled or brazed into tube sheet. Intermediate tube supports shall be provided so that distance between supports does not exceed approximately 3 feet. Supports shall be fitted to the tubes in a manner that will preclude corrosion, vibration, and abrasion. Minimum tube wall thickness shall be 0.028 inches.

Water boxes or removable elbows shall be fitted and arranged to permit cleaning of tubes without disturbing piping beyond elbows. Elbows shall be flanged- or grooved-coupling type.

Condenser performance shall be based on a maximum water velocity of 10 feet per second (fps) and a fouling factor of 0.00025. Design and construction provisions shall preclude tube failure due to erosion.

2.4 COOLER (REFRIGERANT EVAPORATOR)

Cooler shall conform to the requirements specified herein in paragraph entitled, "Condenser," and the following:

Cooler capacity shall be based on refrigerant suction temperature in excess of 32 degrees F and a fouling factor of 0.00010.

A safety relief device shall be provided in compliance with ASHRAE 15 1994.

2.5 PURGE SYSTEM

When R-123 refrigerant is used, a purge system shall be provided and connected to the main refrigeration system. When in operation, the purge system shall function to automatically remove air, water vapor, and noncondensable gases from the refrigeration system and to condense, separate, and return to the system any refrigerant present therein. The purge system shall be manually or automatically started and stopped and shall be assembled as a compact unit. The purge system shall be complete with operating and safety devices and with an oil separator if recommended by the manufacturer. Minimum purge efficiency shall be 0.005 pound refrigerant per pound of air.

2.6 PUMP-OUT SYSTEM

Units operating with refrigerant having positive pressure at 75 degrees F (HCFC-22, HFC-134a, etc.), shall have the capability of storing the entire refrigerant charge in the condenser or shall provide a pump-out system for each machine complete with transfer pump, condensing unit and tank constructed in accordance with ASME Code for unfired pressure vessels bearing the National Board stamp. Provide isolation valves for storage of refrigerant charge in the condenser.

Pump-out systems shall be supplied and warranted by the chiller manufacturer.

2.7 CONTROL AND CONTROL PANELS

The chiller shall be controlled by a stand-alone Direct Digital Control (DDC) System. The panel shall be micro-processor based, with factory packaging and testing of all required control components for reliable equipment operation.

The control panel shall provide control of the chiller operation and monitoring of chiller sensors, actuators, relays, and switches. The panel shall be a complete system for stand alone chiller control and includes controls to safely and efficiently operate the chiller.

The control panel shall monitor such safeties as motor starting and running, time between compressor/motor starts, low chilled water temperature, high condenser refrigerant pressure, low evaporator refrigerant temperature, evaporator and condenser water flows, low oil pressure, high oil temperature, and proper operation of unit controls and sensors. All of the compressor motor bearings shall have factory installed temperature sensors installed in the oil return lines. If any oil temperature reaches or exceeds a set value, the control panel shall shut down the chiller operator and display the diagnostic.

The control panel shall incorporate advanced motor protection to protect the motor throughout the starting and running cycles from the adverse affects of:

- a. phase loss
- b. phase imbalance
- c. phase reversal
- d. phase loss/failure
- e. low voltage
- f. distribution fault protection with auto restart consisting of three-phase, current sensing devices that monitor the status of the current.

Provide the following pressure gauges with the control panel:

- a. evaporator refrigerant pressure
- b. condenser refrigerant pressure
- c. low oil sump pressure

d. high oil pressure

Provide a "Starts" counter and "Running Time" function in the control panel. The front of the panel shall display the following:

- a. entering and leaving evaporator water temperature
- b. entering and leaving condenser water temperature
- c. electrical current limit setpoint
- d. chiller operating mode
- e. chiller diagnostics
- f. oil pressure gages
- g. purge pressure gages
- h. oil temperature
- i. refrigerant evaporator temperature/pressure
- j. refrigerant condenser temperature/pressure
- k. safety cutouts

Provide evaporator freeze protection and low limit control. This control shall be used to avoid low evaporator refrigerant temperature trip-outs during critical periods of operation. The control shall take progressively more aggressive load limiting action in response to the severity of the rate of change and the actual value of the evaporator refrigerant temperature. A diagnostic reflecting the operating status shall be automatically displayed at the front panel whenever this control is in effect.

The control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.

The control panel shall provide a relay output to control the condenser water flow to the chiller.

Provide chiller limit control to include a pressure transducer and interconnecting piping and wiring. This control shall be used to avoid high condenser refrigerant pressure trip-outs during critical periods of operation. The control shall take progressively more aggressive load limiting action in response to the severity of the rate of change and the actual value of the condenser refrigerant pressure. A diagnostic code, reflecting the operating status, shall be automatically displayed at the front panel whenever this control mode is in effect.

The control panel shall provide leaving chilled water temperature reset based on a 4-mA or 0-10 VDC signal from a building automation control system.

Panel diagnostic control shall include time/date event stamping.

2.8 MOTORS

Hermetically sealed motors shall conform to ARI 520 and to requirements for motors as specified herein.

Bearings shall be oil-lubricated, replaceable-sleeve, insertable type.

If chiller unit or any component could be damaged by reverse motor operation, and when proposed chiller unit contains a mechanically driven lubricating-oil pump, the manufacturer's responsibility shall include:

Providing reverse-phase rotation protection, if motor controllers are provided as part of package

Indicating in shop drawings that reverse-phase rotation protection is necessary if motor controllers are in a motor-control center not provided by the manufacturer

2.9 INSULATION

Cooler shell and suction piping between evaporator and first stage of each compressor unit shall be insulated and vapor-sealed. Water boxes shall be insulated to provide for ease of access to heads for inspection and repair. Where motors are the gas-cooled type, insulation and vapor seal shall be provided on the cold-gas inlet connection to the motor.

Vapor-seal material shall be manufacturer's standard color elastomeric unicellular foam in manufacturer's standard thickness to preclude condensation of ambient moisture on any surface under site-operating conditions. If unicellular material is black or is otherwise coated, only polyvinylchloride lacquer shall be used for coating. Any coating that cracks when unicellular material is compressed shall be removed and replaced with specified coating at no additional cost to the Government.

Insulation shall be factory or field applied. Any factory applied insulation damaged during delivery and installation of the chiller shall be repaired to original condition.

2.10 SPECIAL TOOLS

One complete set of special tools, as recommended by the manufacturer, shall be provided for field maintenance of the chiller.

2.11 STARTER

Provide a remote-mounted, high voltage starter. The starter shall be as specified in Section 16286, "Overcurrent Protective Devices". Provide all control interlocks with the starter.

2.12 VERIFICATION OF CAPACITY AND EFFICIENCY

The chiller shall be factory performance tested under full load and 50 percent load conditions in an ARI certified test facility. Proper certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with ARI Standard, ARI 550/590, procedures and tolerances.

A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company.

Preprinted certification will not be acceptable; certification shall be in the original.

2.13 SOUND

Sound Data - The Centrifugal Chiller Sound Pressure Level (SPL), in decibels, (dB), with a reference pressure of 20 micropascals, shall not exceed the values listed below. All ratings shall be in accordance with ARI-STD-575.

A minimum of 75 percent of the sound data points along the length of the machine shall be taken and established as the minimum percentage of total possible points used to determine sound levels. Provide sound attenuation to meet the following levels with 44 degrees F leaving chilled water temperature.

<u>Percent Load</u>	Entering Condenser Water Temp. <u>0 Degrees F</u>	<u>dB, A Weighted</u>
100	85.0	79

Sound Pressure Test - The chiller shall have a sound test conducted at the factory at 100 percent and 50 percent load prior to shipment to confirm the Sound Pressure Levels. The factory test shall be in accordance with ARI-STD-575, Procedures and Tolerances. A certified test report shall be submitted for approval.

2.14 REFRIGERANT MONITOR

Integrate controls with refrigerant monitor for existing system.

An oxygen deficiency monitor is not acceptable in lieu of a refrigerant monitor.

2.15 Exhaust Fan: EX-1

Side wall mounted exhaust fan shall be centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The leakproof fan housing shall be constructed with a one piece wind band with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.

Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a ten square inch tube free of discharge contaminants. Motors and

drives shall be readily accessible for maintenance.

Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150 percent of drive horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts.

Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.

All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated, as specified, and in accordance with manufacturer's instructions.

3.2 MANUFACTURER'S REPRESENTATIVE

The services of a competent factory-trained representative shall be provided to supervise the assembly, charging, testing, and startup of equipment; in addition, Government personnel shall receive 8 hours of instructions in proper operation and maintenance procedures.

A start-up log shall be furnished by the manufacturer to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.

3.3 REFRIGERANT AND OIL CHARGE

The unit shall be completely charged with refrigerant and oil before operation.

3.4 FIELD TESTING

Upon completion of the installation, and within 60 calendar days after the date of initial operation, performance tests shall be conducted in the presence of the Contracting Officer. These tests shall be conducted until the performance of the system is proven, with 8 hours of successful operation as a minimum period. Any equipment defects or performance deficiencies shall be corrected, and the tests repeated until performance is fully satisfactory. Water flows shall be determined from pressure-drop

across chiller and condenser, and from pump curves. Calibrated test instruments shall be provided. The Government will provide load.

Each unit shall be tested for leaks under pressure and shall be evacuated and dehydrated to 35 degrees F, wet bulb, or an absolute pressure of not over 0.24 inch of mercury.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15628

ABSORPTION WATER CHILLERS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 GENERAL
- 2.2 LOW TEMPERATURE GENERATOR/CONDENSER-EVAPORATOR/ABSORBER
- 2.3 HEAT EXCHANGERS
- 2.4 PUMPS
- 2.5 PURGE
- 2.6 HIGH TEMPERATURE GENERATOR
- 2.7 CONTROL PANEL
 - 2.7.1 Control Functions
 - 2.7.2 System Features And Functions
 - 2.7.3 Adaptive Limits
 - 2.7.4 System Protection
 - 2.7.5 Monitor And Displays
 - 2.7.6 Interfaces To Unit Control Panel

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 MANUFACTURER'S REPRESENTATIVE
- 3.3 REFRIGERANT AND OIL CHARGE
- 3.4 FIELD TESTING

-- End of Section Table of Contents --

SECTION 15628

ABSORPTION WATER CHILLERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 15 (2001) Safety Standard for Refrigeration
Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION(ISO)

ISO 9001 (2000) Quality Management Systems -
Requirements

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittals," in sufficient detail to show full compliance with the
specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following
items:

Absorption Water Chiller
Purge System
Motors
Control and Control Panels
Vibration Isolation

SD-04 Drawings

Connection Diagrams shall be submitted indicating the relations
and connections of the following items. The drawings shall
indicate the general physical layout of all controls, and internal
tubing and wiring details.

Absorption Water Chillers
Purge System

Motors
Control and Control Panels

SD-09 Reports

Test Reports for chiller unit shall be submitted indicating the results of Performance Tests performed in accordance with the paragraphs entitled, "Field Testing" of this section.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Absorption Chiller System. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 3/8-inch holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

The Contractor shall provide classroom and field instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory trained personnel or qualified representative. The Contracting Officer shall be given seven calendar days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids, shall be made available to the Contracting Officer.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

PART 2 PRODUCTS

2.1 GENERAL

Unit shall be a complete double effect steam or hot water fired absorption chiller package built in an ISO 9001 environment. Chiller shall consist of high temperature generator, low temperature generator/condenser section, evaporator/absorber section, controls, pumps, heat exchangers, and steam control valve. The unit shall be of hermetic design, factory assembled and leak tested prior to shipment. The unit may be separated and shipped

disassembled for rigging purposes. The control panel, energy valve, and sensors shall be factory installed. The unit shall be painted prior to shipping with two coats consisting of a water base air dry primer and finish coat. The following features shall be included:

- Automatic purge system
- Factory mounted and tested microprocessor controls
- Factory installed cooling-water crossover pipe
- Lithium bromide filter
- .028 inch wall 95-5 CuNi or copper smooth surface low-temp generator tubes
- .028 inch wall 439 stainless steel, or 70/30 CuNi, smooth surface hi-temp generator tubes
- .028 inch wall copper smooth surface condenser tubes
- .025 inch copper enhanced surface evaporator tubes
- .022 inch wall 95-5 CuNi, or .028 inch wall copper, smooth surface absorber tubes
- 1-pass 150 psi generator water box with race faced flange connection
- 1-pass condenser, 2 or 3-pass abs 150 psi marine water boxes with victaulic connection
- 2-pass 150 psi evaporator water box with victaulic connection
- Absorber water inlet left end and condenser water outlet right end (refer to plans). Both on left end is permitted if piping configuration shown on plans is not available by chiller manufacturer. (Contractor shall neatly route outlet piping to suit if both on left end)
- Evaporator water inlet and outlet connections on right end (refer to plans)
- Condenser and absorber water box fluid type - water
- Evaporator water box fluid type - water
- 2-way 2 inch 150 pound energy valve
- Factory installed energy valve
- Stainless steel evaporator pan
- Standard factory paint on entire unit
- Standard Absorption liquid chiller nameplate on main control panel door
- Factory assembled unit for domestic shipping
- 460V fused disconnect switch control panel power connection
- Control panel mounted clear language display
- Variable solution flow diagram
- Manufacturer supplied bromide
- 150 psi NEMA-1 flow switches - quantity of 2 (for field installation)
- Neoprene isolation mounting pads
- 1 year parts and labor warranty from the time of unit startup

2.2 LOW TEMPERATURE GENERATOR/CONDENSER-EVAPORATOR/ABSORBER

The shell material shall be carbon steel. Standard low temperature generator tube material shall be cupro-nickel or copper. Evaporator shall be cupro-nickel or copper, absorber shall be cupro-nickel or copper, and condenser copper. Tubes shall be mechanically rolled into the tubesheets and be replaceable from either end. Condenser, evaporator and absorber tube supports shall be fixed. The low temperature generator shall consist

of fixed and floating tube supports to allow for even tube expansion. Spray systems shall be replaceable from end of unit without sacrificing the hermetic integrity of the unit.

Design working pressure for the water boxes shall be 150 psig. All tube bundles are to be tested at 150 percent of design working pressure. All water boxes, except the second-stage generator, shall have gasketed removable covers for access. Marine type water boxes shall be provided on the condenser and absorber section. Water connections shall be provided with either victualic or raised-face flanged connections.

2.3 HEAT EXCHANGERS

Three welded hermetic plate solution heat exchangers shall be 300 series stainless steel or shell and tube heat exchanger with CuNi tubing.

2.4 PUMPS

Solution and refrigerant shall be circulated by means of multiple hermetic, single stage centrifugal pumps. The pump impeller shall be cast iron with a steel shaft supported by 2 tapered carbon bearings. The bearings shall be lubricated and the motor cooled by the fluid that is pumped. The system shall be designed for variable solution flow.

2.5 PURGE

Purge system shall include a collection chamber in absorber section, an eductor for moving non-condensables to the condenser, purge to collect the non-condensables in an external storage tank, and vacuum pump for removal of the non-condensables. The purge shall operate automatically to remove non-condensables from the unit during periods of chiller operation and shutdown. Logging of purge information is to be provided via the unit control panel.

2.6 HIGH TEMPERATURE GENERATOR

The shell shall be carbon steel. Tube sheets shall be steel and standard generator tubes constructed of stainless steel or 70/30 CuNi. The high temperature generator shall have fixed and floating tube supports to allow for even tube expansion or be of U-tube design. The steam side of the generator is to be designed and stamped for 150 PSI ASME construction. Unit High temperature generator shall include a rupture disk which is sized to meet ASHRAE 15. A field or factory mounted and wired energy control valve shall be provided.

2.7 CONTROL PANEL

The unit control panel shall be a microprocessor-based chiller control system that provides complete stand-alone operation. It shall be a factory mounted package including a full compliment of controls to safely and efficiently operate the absorption liquid chiller. The control panel shall consist of the following items:

2.7.1 Control Functions

- * Chilled water temperature control
- * Concentration control

2.7.2 System Features And Functions

- *User interface with a 40 character, line display and keypad, capable of displaying English units
- *Passwords for protection of unit setup and configuration
- *Automatic and manual control of solution and refrigerant pumps
- *Economical solution flow control of the low temperature solution pump and absorber pump via variable solution flow design
- *Anti-crystallization through dilution control
- *Automatic and manual purge system
- *Chilled water reset
- *2-way valve assembly for steam flow control.
- *Absorber/Condenser pump control

2.7.3 Adaptive Limits

- *Evaporator water temperature limit
- *High interstage pressure limit
- *High interstage temperature limit
- *Low absorber/condenser limit
- *Soft-loading control

2.7.4 System Protection

- * Evaporator freeze protection
- * Chilled water flow confirmation
- * Cooling water flow confirmation
- * High interstage pressure cutout to prevent excessive pressure
- * Emergency stop/shutdown

2.7.5 Monitor And Displays

- * Chilled water temperature leaving
- * Solution concentration
- * Solution temperatures
- * Chiller run time and starts
- * Purge operation and run time

2.7.6 Interfaces To Unit Control Panel

- *External machine manual reset alarm indication output
- *External machine auto reset warning indication output
- *External limit warning indication output
- *Maximum capacity indication output
- *External auto-stop/emergency shutdown
- *External chilled water setpoint

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated, as specified, and in accordance with manufacturer's instructions.

1. Install the unit on a level surface. Neoprene isolation pads supplied by the manufacturer shall be placed under the unit.
2. Connect unit control panel to all operating external safety and auxiliary control devices.
3. Insure that piping adjacent to the machine does not restrict removal of headers for inspection, cleaning and removing tubes.
4. Provide pressure gauges and thermometers for temperature and pressure readings at the inlet and outlet of the evaporator, at the inlet and outlet of the absorber, and at the outlet of the condenser.
5. Provide balancing valves in all external water circuits to allow balance and trim of the system.
6. Provide strainers ahead of all automatic modulating valves to insure proper operation.
7. Insulate the chilled water headers and other portions of the unit, as pointed out in the manufacturer's installation literature, to prevent condensation on cold surfaces and heat loss from hot surfaces to the equipment room. External unit pipes with surface temperatures sufficiently hot to constitute a danger to operating personnel shall also be insulated. Refer to Section 15080.
8. Install a flow switch in the chilled water circuit and interlock it with the starting control circuit of the unit. Proof of flow is required prior to permitting unit operation. Provide and install a flow switch in the condenser water circuit which shall be interlocked with the starting control circuit of the unit such that proof of flow is required to prevent machine damage. Maintain manufacturer's required length of straight pipe upstream of flow switch.
9. Provide necessary distilled or demineralized water for refrigerant charge, and trim charge.
10. Provide labor to charge the machine with lithium bromide solution and refrigerant water, and assist in machine starting and calibration under supervision of the manufacturer's representative.
11. Provide sufficient sized vacuum pump and personnel to evacuate the unit prior to charging (if required).
12. Leak test in accordance with instructions in the manufacturer's installation bulletin.
13. Connect the rupture disc to an appropriate floor drain. The vent piping shall be supported and connected by a flexible connector to prevent stress at the connection.

14. Install any control components provided by the manufacturer for installation external to the machine.
15. Install required power supply wiring to the control panel. Refer to Division 16 specifications.

3.2 MANUFACTURER'S REPRESENTATIVE

The services of a competent factory-trained representative shall be provided to supervise the assembly, charging, testing, and startup of equipment; in addition, Government personnel shall receive 8 hours of instructions in proper operation and maintenance procedures.

A start-up log shall be furnished by the manufacturer to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.

3.3 REFRIGERANT AND OIL CHARGE

The unit shall be completely charged with refrigerant and oil before operation.

3.4 FIELD TESTING

Upon completion of the installation, and within 60 calendar days after the date of initial operation, performance tests shall be conducted in the presence of the Contracting Officer. These tests shall be conducted until the performance of the system is proven, with 8 hours of successful operation as a minimum period. Any equipment defects or performance deficiencies shall be corrected, and the tests repeated until performance is fully satisfactory. Water flows shall be determined from pressure-drop across chiller and condenser, and from pump curves. Calibrated test instruments shall be provided. The Government will provide load.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15720

AIR HANDLING UNITS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 GENERAL DESCRIPTION
- 2.2 CASING
 - 2.2.1 Construction
 - 2.2.2 Insulation
 - 2.2.3 Access Doors
 - 2.2.4 Drain Pans
- 2.3 FANS
 - 2.3.1 General
 - 2.3.2 Performance Ratings
 - 2.3.3 Sound Ratings
 - 2.3.4 Mounting
- 2.4 BEARINGS AND DRIVES
 - 2.4.1 Bearings
 - 2.4.2 V-Belt Drive
- 2.5 COILS
 - 2.5.1 General Fabrication
 - 2.5.2 Heating Coils
 - 2.5.3 Configuration
 - 2.5.4 Water Cooling Coils

PART 3 EXECUTION

- 3.1 AHU EQUIPMENT INSTALLATION
- 3.2 AHU TESTING

-- End of Section Table of Contents --

SECTION 15720

AIR HANDLING UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410 (1991) Forced-Circulation Air-Cooling and Air-Heating Coils

ARI 430 (1999) Central-Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 211 (1994) Certified Ratings Program - Air Performance

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117 (1997) Standard Test Method of Salt Spray (Fog) Testing

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51 (1999) Laboratory Methods of Testing Fans for Rating

ASHRAE 62 (2001) Ventilation for Acceptable Indoor Air Quality

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1999) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 181 (1996) UL Standards for Safety Factory-Made Air Ducts and Air Connectors

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for Air Handling Units in accordance with the specification. Data shall consist of use life, total static pressure and coil face area classifications, and performance ratings.

Manufacturer's Catalog Data shall be submitted for the following items:

- Unit Cabinet
- Fans
- Drain Pans
- Insulation
- Plenums
- Draw-Through AHU
- Spare Parts
- Vibration Isolation
- Coils

SD-04 Drawings

Fabrication/Erection/Installation Drawings shall be submitted for Air Handling Units.

SD-19 Operation and Maintenance Manuals

Contractor shall submit Operation and Maintenance Manuals prior to testing the Air Handling Units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

PART 2 PRODUCTS

2.1 GENERAL DESCRIPTION

Unit shall be a factory-supplied, central station air handler. Unit may consist of a fan with the factory-installed components as indicated.

Units shall ship in the number of sections necessary to meet project requirements. All sections shall be flanged and gasketed to allow easy assembly and disassembly

2.2 CASING

2.2.1 Construction

Unit sections shall be supplied with 12-gage G90 galvanized steel structural support rails. Perimeter 10 gage lifting lugs for overhead rigging shall be provided on each section. Slings of units in lieu of lifting lugs is not acceptable.

Exterior panels (top, sides, and bottom) shall be constructed of G90 galvanized steel, with prepainted, baked enamel finish. These panels shall be capable of withstanding a 500-hour salt spray test per ASTM B 117.

Interior panels shall be 20-gage G90 galvanized steel. Perforated (20-gage) interior panels are to be in fan sections.

Casing panels shall be removable for easy access to unit. All panels shall be gasketed to ensure a tight seal.

Each component section shall have mating flanges for assembly. The flange shall extend around the complete perimeter of each section. Fasteners shall be located no further than 12 inches on center. The manufacturer shall install closed cell gasket for full perimeter coverage.

The fan section shall have a G90 galvanized steel floor of sufficient size to enable field personnel to service or adjust the motor and drive without damaging the insulation. A double-wall hinged access door shall be provided on both sides of the fan section.

All coil sections shall be constructed of insulated, double-wall, galvanized steel panels. Coil sections shall have coil tracks to facilitate coil removal.

Filter sections shall be designed and constructed to house the specific type of filter. A double-walled hinged access door shall be provided on both sides of the section.

All mixing boxes and filter-mixing boxes shall have a double-wall hinged access door. Filter-mixing boxes shall have doors on both sides of component. Mixing boxes shall have floors of G90 galvanized steel to protect insulation.

Access sections shall have a double-wall hinged access door on both sides of component. Sections shall have floors of G90 galvanized steel to protect insulation.

2.2.2 Insulation

Each section shall be factory insulated. Insulation shall have full coverage waterproof adhesive to firmly secure the material to the unit casing. Insulation shall meet the erosion requirements of UL 181. Insulation and insulation adhesive shall comply with NFPA 90A requirements for flame spread and smoke generation.

Two-inch, 1-1/2 pound per cubic foot density - Panels shall have a R-value of 8.65, fiberglass insulation with a density of not less than 1-1/2 pound

per cubic foot.

2.2.3 Access Doors

Access doors shall be of double wall construction. Hinge pins shall be non-removable to avoid loss. Sufficient handles shall be provided to assure positive closure. Doors shall be gasketed and shall open outward for negative pressure sections and inward for positive pressure sections. Doors shall be provided on both sides of all access, fan and filter sections. All fan and access sections must have latch handles on the inside and outside of access doors to facilitate safe ingress and egress of confined spaces.

2.2.4 Drain Pans

Drain pans shall be constructed of insulated double wall stainless steel. The pan shall be sloped toward the drain fitting. Drain pan shall have a recessed bottom drain design with integral FPT elbow for side discharge and trapping. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE 62 -R.

2.3 FANS

2.3.1 General

Forward-curved fans shall have one double width double inlet (DWDI) fan wheel and scroll. They shall be constructed of galvanized steel, or bonderized steel painted with baked enamel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Airfoil fan sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design. They shall be painted with zinc chromate primer and enamel paint. Fans shall have a minimum AMCA Class II rating. Backward inclined or backward-curved fans do not have the efficiency of airfoil blades and shall not be acceptable.

Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25 percent below the first critical, and shall be statically and dynamically balanced as an assembly.

Fan shafts shall be solid steel, turned, ground polished and coated with rust preventative oil.

Fan motor shall be mounted within the fan section casing on slide rails equipped with 2 adjusting screws. Motor shall be high efficiency, open drip-proof or totally enclosed fan cooled NEMA Design B with size and electrical characteristics as shown on the equipment schedule. Premium efficiency motors shall be used. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All motors shall have a plus or minus 10 percent voltage

utilization range and a 1.15 minimum service factor.

2.3.2 Performance Ratings

Fan performance shall be rated and certified in accordance with ARI 430.

2.3.3 Sound Ratings

Manufacturer shall publish first through eight octave sound power for fan discharge and casing radiated sound.

2.3.4 Mounting

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly which shall be isolated from the outer casing with factory-installed 2-inch deflection spring isolators and vibration absorbent fan discharge seal. The isolation system shall be designed to conform to seismic zone 4 requirements.

2.4 BEARINGS AND DRIVES

2.4.1 Bearings

Self-aligning, grease lubricated, anti-friction with lubrication fittings extended to drive side of fan section. Exterior grease fittings are to be provided.

Forward-curved fans - Heavy duty pillow block type, self-aligning, re-greasable ball or roller type bearings selected for a minimum average life (L-50) of 200,000 hours.

Airfoil fans - Heavy duty pillow block type, self-aligning, re-greasable ball or roller type bearings selected for a minimum average life (L-50) of 200,000 hours.

2.4.2 V-Belt Drive

Drive shall be designed for a minimum 1.5 service factor. Drives shall be variable pitch for motors 15 hp and less and fixed-pitch for 20 hp and larger. All drives shall be factory mounted, with sheaves aligned.

2.5 COILS

All water and steam coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with ARI 410. All water coils shall be tested at 450 psig air pressure.

2.5.1 General Fabrication

All water coils shall have 1/2-inch OD seamless copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Tube wall thickness of 0.025-inch shall be supplied.

Aluminum plate fin type with belled collars.

Aluminum-finned coils shall be supplied with die formed casing and tube sheets of mill galvanized steel.

2.5.2 Heating Coils

Headers shall be non-ferrous with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit.

2.5.3 Configuration

Coils shall be drainable, with non-trapping circuits. Working pressure shall be 175 psig at 400 degrees F.

2.5.4 Water Cooling Coils

Headers shall be non-ferrous with steel MPT connections. Headers shall have threaded drain and vent connections accessible from outside the unit casing.

Coils shall be drainable, with non-trapping circuits. Working pressure shall be 300 psig at 200 degrees F.

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations.

3.2 AHU TESTING

AHU and components shall be performance tested and rated in accordance with AMCA 211 and ASHRAE 51. AHU ratings shall be in accordance with ARI 430.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15818

MEDIUM/HIGH PRESSURE DUCTWORK

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DESIGN REQUIREMENTS
- 1.3 SCOPE OF WORK
- 1.4 SUBMITTALS

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Galvanized Steel Ductwork Materials
 - 2.1.2 Brazing Materials
 - 2.1.3 Mill-Rolled Reinforcing and Supporting Materials
- 2.2 COMPONENTS
 - 2.2.1 Turning Vanes
 - 2.2.2 Dampers
 - 2.2.3 Flexible Connectors for Sheet Metal

PART 3 EXECUTION

- 3.1 PREPARATION
- 3.2 INSTALLATION
- 3.3 APPLICATION
 - 3.3.1 Rectangular Sheet Metal Ducts
 - 3.3.1.1 Medium-Pressure Gages, Joints, and Reinforcement
 - 3.3.1.2 Medium- and High-Pressure Branches, Inlets, Outlets
 - 3.3.2 Duct Supports
 - 3.3.3 Flexible Connectors for Steel Metal
 - 3.3.4 Insulation Protection Angles
 - 3.3.5 Duct Probe Access
 - 3.3.6 Openings in Roofs and Walls
- 3.4 FIELD QUALITY CONTROL
 - 3.4.1 Ductwork Leakage Test
 - 3.4.2 Inspection
- 3.5 DUCTWORK CLEANING PROVISIONS

-- End of Section Table of Contents --

SECTION 15818

MEDIUM/HIGH PRESSURE DUCTWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328 (1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123 (2000) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 36/A 36M (2000) Standard Specification for Structural Steel

ASTM A 653/A 653M (2001) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process

ASTM A 924/A 924M (1999) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-03 (1997) Handbook, Fundamentals (IP Edition)

ASHRAE-06 (2000) Handbook, HVAC Systems and Equipment (IP Edition)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8 (1992) Specification for Filler Metals for Brazing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1999) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION
(SMACNA)

SMACNA-06 (1985; 1st Ed) HVAC Duct Construction
Standards - Metal and Flexible

SMACNA-09 (1989; 1st Ed) HVAC Duct Systems
Inspection Guide

1.2 DESIGN REQUIREMENTS

Section 15003, "General Mechanical Provisions," apply to work specified in this section.

Section 15055, "Welding Mechanical," applies to work specified in this section.

1.3 SCOPE OF WORK

High velocity systems shall encompass ductwork where:

Minimum air velocity exceeds 2,000 feet per minute (fpm) or static pressure exceeds 2 inches water gage (wg).

Medium static pressure ranges from over 2 inches wg through 3 inches wg, positive or negative, or over 3 inches wg through 6 inches wg positive.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Galvanized Steel Ductwork Materials
Turning Vanes
Dampers
Flexible Connectors

SD-04 Drawings

Fabrication/Erection/Installation Drawings shall be submitted for Medium/High Pressure Ductwork Systems.

SD-07 Schedules

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing

reference numbers, warranty information, and fabrication site information.

SD-18 Records

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

SD-19 Operation and Maintenance Manuals

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Medium/High Pressure Ductwork. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Ductwork Materials

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 924/A 924M and ASTM A 653/A 653M, Designation G90. Duct surfaces to be painted shall be treated by phosphatizing.

Sheet metal gages and reinforcement thickness shall conform to ASHRAE-06, Chapter 16, ASHRAE-03, Chapter 32 and SMACNA-06.

2.1.2 Brazing Materials

Brazing materials shall be silicon bronze conforming to AWS A5.8.

2.1.3 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, wherever in contact with sheet metal ducting, shall be galvanized to commercial weight of zinc or coated with materials conforming to ASTM A 123.

Equivalent strength, proprietary design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 COMPONENTS

2.2.1 Turning Vanes

Turning vanes shall be double-wall type, commercially manufactured for high-velocity system service.

2.2.2 Dampers

Low pressure drop, high-velocity manual volume dampers, and high-velocity fire dampers shall be constructed in accordance with ASHRAE-06, Chapter 16, ASHRAE-03, Chapter 32 and SMACNA-06.

2.2.3 Flexible Connectors for Sheet Metal

Connectors shall be UL listed, 30-ounce per square foot, waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with chloroprene. Clear width, not including clamping section, shall be 6 to 8 inches.

PART 3 EXECUTION

3.1 PREPARATION

Sheet metal construction shall be provided in accordance with the recommendations for best practices in ASHRAE-06, Chapter 16, SMACNA-06, NFPA 90A, and ASHRAE-03, Chapter 32.

Where construction methods for certain items are not described in the referenced standards or herein, the work shall be performed in accordance with recommendations for best practice defined in ASHRAE-06.

Sheet metal surfaces to be painted and surfaces to which adhesives are to be applied shall be clean and free of oil, grease, and deleterious substances.

Duct strength shall be adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Leaktight, automatic relief devices shall be provided.

Supplementary steel shall be designed and fabricated in accordance with AISC S328.

3.2 INSTALLATION

Fabrication shall be airtight and shall include reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise, and excessive deflection at specified maximum system air pressure and velocity.

3.3 APPLICATION

3.3.1 Rectangular Sheet Metal Ducts

3.3.1.1 Medium-Pressure Gages, Joints, and Reinforcement

Minimum sheet metal gages, joints, and reinforcements between joints shall be in accordance with ASHRAE-06, Chapter 16, ASHRAE-03, Chapter 32 and SMACNA-06.

3.3.1.2 Medium- and High-Pressure Branches, Inlets, Outlets

Branches, inlets, and outlets shall be installed to minimize air turbulence and to ensure proper airflow.

3.3.2 Duct Supports

Duct support shall be installed in accordance with ASHRAE-06, Chapter 16, ASHRAE-03, Chapter 32 and SMACNA-06. Duct hangers shall meet the minimum size specified in ASHRAE-06, Chapter 16, ASHRAE-03, Chapter 32 and SMACNA-06. Two hangers shall be provided where necessary to eliminate sway. Support attachment to duct surfaces, shall be by solid rivet, bolt, or welding 4 inches on center.

Selection of hanging system shall be at the Contractor's option, and shall take into account the location and precedence of work under other sections, interferences of various piping and electrical conduit, equipment, building configuration, structural and safety factor requirements, vibration, and imposed loads under normal and abnormal service conditions. Support sizes, configurations, and spacings are given to show the minimal type of supporting components required. If installed loads are excessive for the specified hanger spacing, hangers, and accessories heavier-duty components shall be provided or hanger spacing shall be reduced. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member, shall be replaced or the condition shall otherwise be alleviated. Special care shall be exercised to preclude cascade-type failures.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts, masonry anchors, and fasteners shall be approved for the application.

Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. A 72-hour load-carrying capacity shall be verified by a certified independent laboratory.

Hanger spacing shall provide a 20-to-1 safety factor for supported load.

Maximum load supported by any two fasteners shall be 100 pounds.

Friction rod assemblies are not acceptable.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 10 feet, with lesser spans as required by duct assemblies, interferences, and permitted loads imposed.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross braced to eliminate sway vertically and

laterally.

Rectangular ducts up to 36 inches shall be supported by strap-type hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers are not acceptable.

Rectangular ducting, 36 inches and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Duct hangers shall not penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

<u>WIDTH OF DUCT, INCHES</u>	<u>MINIMUM BOTTOM ANGLE SIZE, INCHES</u>
30 and smaller	1-1/4 by 1-1/4 by 1/8
31 to 48	1-1/2 by 1-1/2 by 1/8
49 to 72	1-1/2 by 1-1/2 by 3/16
73 to 96	2 by 2 by 1/4
97 and wider	3 by 3 by 1/4

3.3.3 Flexible Connectors for Steel Metal

Air-handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkles caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.4 Insulation Protection Angles

Galvanized 20-gage sheet, formed into an angle with a 2-inch exposed long leg with a 3/8-inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness, shall be provided.

Angles shall be installed over all insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Angles shall be fastened in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Angles shall be installed after final insulation covering has been applied.

3.3.5 Duct Probe Access

Holes shall be provided with neat patches, threaded plugs, or threaded or twist-on caps for air-balancing pitot tube access. Extended-neck fittings shall be provided where probe access area is insulated.

3.3.6 Openings in Roofs and Walls

Building openings are fixed and equipment shall be provided to suit.

3.4 FIELD QUALITY CONTROL

3.4.1 Ductwork Leakage Test

Contractor shall conduct complete leakage test of new ductwork in accordance with Section 15950, "Testing, Adjusting and Balancing." Tests shall be performed prior to installing ductwork insulation.

3.4.2 Inspection

Ductwork shall be inspected in accordance with SMACNA-09.

3.5 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer. Dirty assembled ducting shall be cleaned by subjecting all main and branch interior surfaces to airstreams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; and other means approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil- free. After construction is complete, and prior to acceptance of the work, construction dust and debris shall be removed from exterior surfaces.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

- 3.1 WATER SYSTEM TESTING
 - 3.1.1 Test Gages
 - 3.1.2 Test and Acceptance Criteria
- 3.2 AIR AND HYDRONIC SYSTEMS TESTING AND ADJUSTMENT
 - 3.2.1 Hydronic Systems
 - 3.2.1.1 System Balancing, Adjustment, and Acceptance Criteria
 - 3.2.1.2 Test Apparatus and Procedures
 - 3.2.1.3 Hydronic Systems Preparation
 - 3.2.1.4 Operational Test Report
- 3.3 STEAM AND CONDENSATE SYSTEMS TESTING
 - 3.3.1 Test Duration
 - 3.3.2 Test Gages
 - 3.3.3 Acceptance Pressure Testing
 - 3.3.4 Operational Testing
- 3.4 TEST REPORTS

-- End of Section Table of Contents --

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100 (1998; R 2000) Pressure Gauges and Gauge Attachments Incorporating ASME B40.1-1998 and ASME B40.7-1992

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for instruments and equipment to be used during testing.

SD-09 Reports

Test Reports shall be submitted to the Contracting Officer for approval. Six bound copies of the testing, adjusting, and balancing report shall be provided.

SD-13 Certificates

Certificates of Compliance shall be submitted by the Contractor showing independent laboratory certification of test-apparatus calibration data, dated after the award of the contract.

SD-18 Records

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 WATER SYSTEM TESTING

Prior to acceptance of the work, systems shall be tested in the presence of the Contracting Officer.

Tests shall be performed prior to insulation of surfaces, painting, and concealment of work. Systems containing repaired defects shall be retested to original criteria for acceptance, except when waived by the Contracting Officer.

Tests shall be hydrostatic, unless otherwise specified. Water used for testing shall be potable.

Government will supply testing water, but the Contractor shall provide for approved disposal of contaminated water.

Contractor may conduct tests for its own purposes, but the acceptance test shall be conducted as specified herein.

If the test demonstrates that leakage rate exceeds specified limits, the source(s) of leakage shall be determined, defective materials and workmanship shall be repaired or replaced, and the system shall be retested until specified requirements are met.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable-elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any plug used shall be not less than two times the actual test pressure being applied.

Precautions shall be taken to vent the expansive force of compressed air trapped during high-pressure hydrostatic testing to preclude injury and damage.

Contracting Officer may require the removal of system components, such as plugs or caps, to ascertain that the water has reached all parts of the system if purging or vent valves are not provided.

Piping system components such as valves shall be checked for functional operation under system test pressure. Components that could sustain damage due to test pressure shall be removed from piping systems prior to hydrostatic testing.

Leaking gasket joints shall be remade with new gaskets. Leaking copper joints shall be remade with new fittings and new tube ends.

Temperature of water used for testing shall not cause condensation on

system surfaces.

Test media shall not be added to a system during a test for a period specified or to be determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and shall be for a minimum of 2 hours, with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any time during this period after it has been determined that the permissible leakage rate has not been exceeded.

Test records of piping systems tests shall be prepared and maintained. Records shall show test personnel responsibilities, dates, test gage identification numbers, ambient and test water temperatures, pressure ranges, rate of pressure drop, leakage rates, and other system characteristics.

3.1.1 Test Gages

Test gages shall have a 4-1/2 inch or larger dial, be accurate to plus or minus one-half of 1 percent of full-scale range, and have dial graduations and pointer width compatible with readability and one-half the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

3.1.2 Test and Acceptance Criteria

Aboveground water systems shall be tested at 150 pounds per square inch (psi) and the applied test pressure shall be maintained without further addition of test media for not less than 2 hours. Maximum allowable pressure drop shall be 2 psi, or as approved.

Maximum allowable leakage for the piping installation (gallons per hour) shall be indicated by not more than a 5 percent drop of total system pressure.

3.2 AIR AND HYDRONIC SYSTEMS TESTING AND ADJUSTMENT

3.2.1 Hydronic Systems

3.2.1.1 System Balancing, Adjustment, and Acceptance Criteria

Systems final flow conditions shall be within the following limits:

Flow station delivery: Plus or minus 5 percent of design gpm at design temperature

3.2.1.2 Test Apparatus and Procedures

Test apparatus shall consist of devices required for hydronic systems flow measuring and balancing including:

Pressure gages and fittings

Dry bulb thermometers

Differential-pressure gages or manometers

Thermometer wells, where necessary for balancing, but where permanent installation of thermometers is not indicated or required

3.2.1.3 Hydronic Systems Preparation

Hydronic systems shall be prepared in the following manner:

Proper installation of valves and balancing devices shall be verified.

Valves shall be opened to full-open position, including coil-stop valves, bypass valves, and return-line balancing cocks.

Strainer screens shall be removed and cleaned.

Water in each system shall be examined to determine that it has been treated.

Air vents shall be checked at high points to verify proper installation and operation.

Water-circulating pumps shall be set to proper gpm delivery.

Flow of chilled water through chillers shall be adjusted.

Leaving-water and return-water temperatures through chiller and convertors shall be checked.

Instrumentation shall be provided to record apparatus motor kW input and power factor. If motor identification plate current capacity and larger starter is exceeded, next-size larger motor and wiring shall be provided, as necessary.

Cooling tower-water flow shall be checked.

3.2.1.4 Operational Test Report

Operational test report shall provide data on systems tested, test apparatus data, and orifice or Venturi data, and shall include:

For each heating and cooling element:

Inlet water temperature

Leaving water temperature

Pressure drop across each element

For each apparatus such as chiller, cooling tower, and converter:

Inlet water temperature

Leaving water temperature

Pressure drop across units

Calculated and measured waterflow

Mechanical specifications of units

Rated and actual kW input and power factor for motors

Heating- and cooling-element data

3.3 STEAM AND CONDENSATE SYSTEMS TESTING

Prior to acceptance of the work, completed systems shall be tested in the presence of the Contracting Officer.

System shall be subjected to pressure tests to determine structural integrity, and to operational and cyclic tests, as necessary, to determine that system functions and operates as required.

After pressure tests and cleaning operations have been satisfactorily completed, system components shall be adjusted for proper operation within the design and operating characteristics published by the component manufacturer. In addition to the services of an authorized representative of the manufacturer, the Government reserves the right to require the services of an authorized representative of a component manufacturer if the Contractor is unable to adjust a component. Contractor shall arrange for such services and defray the cost.

3.3.1 Test Duration

Duration of a test will be determined by the Contracting Officer.

A pressure test shall be held for a minimum of 2 hours and a maximum of 24 hours.

A test may be terminated by the Contracting Officer at any time after it has been determined that the system meets specified requirements.

3.3.2 Test Gages

Contractor's test gages shall conform to ASME B40.100 and shall have 8-inch or larger dials. Maximum permissible scale range for a given test shall be such that the pointer shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

3.3.3 Acceptance Pressure Testing

Testing shall take place during steady-state ambient temperature conditions.

Tests shall be hydrostatic unless otherwise specified.

Tests of steam and condensate systems shall be made using potable water.

Systems shall be tested at 1-1/2 times primary working steam pressure rating of system components, and the applied pressure shall be maintained without further addition of test media for not less than 1 hour. Maximum allowable pressure drop shall be 1 psi, or as approved.

Contractor may conduct tests for its own purposes, but the acceptance test shall be conducted as specified herein.

If testing reveals that leakage exceeds specified limits, the leaks shall be isolated and repaired, defective materials shall be replaced where necessary, and the system shall be retested until specified requirements are met. Leaking gasket joints shall be remade with new gaskets and new flange bolting. Old gaskets and bolting shall be discarded. Leaking tubing joints shall be remade with new fittings and new tube ends.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any plug used shall be not less than two times the test pressure.

Precautions shall be taken, when venting compressed air trapped during high-pressure hydrostatic testing, to preclude injury and damage. If adequate purging or vent valves are not provided to ensure removal of compressed-air cushion, the Contracting Officer may require the removal of any system component such as plugs and caps to ascertain that the water has reached all parts of the system. Components shall be removed from piping systems prior to hydrostatic testing whenever the component could be damaged by shock or test pressure.

Piping system components, such as valves, shall be checked for functional operation under system test pressure.

Piping shall be subjected to shock developed by a vigorously applied 2-pound hammer, as directed by the Contracting Officer.

Temperature of water used for testing shall not cause condensation on system surfaces.

3.3.4 Operational Testing

System shall be cycled five times, from start to operating thermal conditions, to verify adequacy of construction, system controls, and component performance, unless otherwise approved by the Contracting Officer.

3.4 TEST REPORTS

Final test reports shall be provided to the Contracting Officer. Reports

shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15972

DIRECT DIGITAL CONTROL SYSTEMS (DDC)

PART 1 GENERAL

- 1.1 SUMMARY (Not Applicable)
- 1.2 REFERENCES
- 1.3 SUBMITTALS
- 1.4 RELATED REQUIREMENTS
- 1.5 STORAGE
- 1.6 QUALITY ASSURANCE
 - 1.6.1 Standard Products
 - 1.6.2 Nameplates and Tags
 - 1.6.3 Verification of Dimensions
 - 1.6.4 Drawings
 - 1.6.5 Modification of References

PART 2 PRODUCTS

- 2.1 DDC SYSTEM
 - 2.1.1 Direct Digital Controllers
 - 2.1.1.1 Distributed Control
 - 2.1.1.2 Input/Output (I/O) Point Limitation
 - 2.1.1.3 Environmental Operating Limits
 - 2.1.1.4 Stand-Alone Control
 - 2.1.1.5 Memory
 - 2.1.1.6 Inputs
 - 2.1.1.7 Outputs
 - 2.1.1.8 Proportional Integral Derivative (PID) Control
 - 2.1.1.9 Communications Ports
 - 2.1.1.10 Digital Controller Cabinet
 - 2.1.1.11 Main Power Switch
 - 2.1.2 Terminal Control Units (TCU)
 - 2.1.3 DDC Software
 - 2.1.3.1 Sequence of Control
 - 2.1.3.2 Database Modification
 - 2.1.3.3 Differential
 - 2.1.3.4 Motor and Flow Status Delay
 - 2.1.3.5 Runtime Accumulation
 - 2.1.3.6 Timed Local Override
 - 2.1.3.7 Time Programs
 - 2.1.3.8 Scheduling
 - 2.1.3.9 Point Override
 - 2.1.3.10 Alarming

- 2.1.3.11 Messages
- 2.1.3.12 Trending
- 2.1.3.13 Status Display
- 2.1.3.14 Diagnostics
- 2.1.3.15 Power Loss
- 2.1.3.16 Program Transfer
- 2.1.3.17 Password Protection
- 2.1.4 Workstation
 - 2.1.4.1 Software
- 2.1.5 Panel Mounted Display and Keypad
- 2.2 SENSORS AND INPUT HARDWARE
 - 2.2.1 Field Installed Temperature Sensors
 - 2.2.1.1 Resistance Temperature Detectors (RTDs)
 - 2.2.1.2 Thermistors
 - 2.2.1.3 Temperature Sensor Details
 - 2.2.2 Transmitters
 - 2.2.2.1 Spans and Ranges
 - 2.2.3 Pressure Transmitters
 - 2.2.4 Input switches
 - 2.2.4.1 Differential Static Pressure Switch
 - 2.2.4.2 Induced Current Operated Solid State Switches
 - 2.2.4.3 Timed Local Override
- 2.3 OUTPUT HARDWARE
 - 2.3.1 Valves
 - 2.3.1.1 Valve Assembly
 - 2.3.1.2 Butterfly Valve Assembly
 - 2.3.1.3 Two-Way Valves/Three-Way Valves
 - 2.3.1.4 Valves for Water Service
 - 2.3.2 Actuator
 - 2.3.2.1 Electric
 - 2.3.3 Output Switches
 - 2.3.3.1 Control Relays
- 2.4 ELECTRICAL POWER AND DISTRIBUTION
 - 2.4.1 Transformers
 - 2.4.2 Power Line Surge Protection
 - 2.4.3 Wiring
 - 2.4.3.1 AC Control Wiring
 - 2.4.3.2 Wiring (Direct Digital Controls and Communications)
- 2.5 FIRE PROTECTION DEVICES

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 Wiring Criteria
 - 3.1.2 Digital Controllers
 - 3.1.3 Temperature Sensors
 - 3.1.3.1 Immersion Temperature Sensors
 - 3.1.4 Pressure Sensors
 - 3.1.4.1 Differential Pressure
 - 3.1.5 Control Drawings
- 3.2 ADJUSTMENTS
- 3.3 TRAINING
- 3.4 CALIBRATION AND ADJUSTMENTS
- 3.5 ACCEPTANCE PROCEDURE

3.6 COMMISSIONING PROCEDURE

3.7 SEQUENCE OF OPERATION

-- End of Section Table of Contents --

SECTION 15972

DIRECT DIGITAL CONTROL SYSTEMS (DDC)

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME/ANSI B16.5 (1996) (Errata 1988) (Addenda 1992) Pipe
Flanges and Flanged Fittings

ASME B31.1 (1998) Power Piping

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 126 (1995; R 2001) Standard Specification for
Gray Iron Castings for Valves, Flanges,
and Pipe Fittings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 90A (1999) Standard for the Installation of
Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 506 (2000) UL Standard for Safety Specialty
Transformers

UL 916 (1998; R 2001) Energy Management Equipment

UL 1449 (1996) Transient Voltage Surge Suppressors

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittals," in sufficient detail to show full compliance with the

specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

- DDC Hardware
- DDC Capabilities Workstation Software
- Input Devices Output Devices
- Surge and Transient Protection
- Panel Mounted Display and Keypad

Submit manufacturers' specification sheets for each type of equipment to show compliance with the project specification. For each type of equipment, highlight each compliance item and reference each item to the relevant specification paragraph number. Submit sufficient manufacturers' information to allow verification of compliance by the Contracting Officer.

Equipment and software for which specification compliance data shall be submitted include the following:

- DDC Hardware
- I/O Devices
- Communications Ports
- Protected Memory
- Operating Temperature Limits

DDC Capabilities

- Communications; baud rates, communication ports,
stand-alone
- Trending
- Alarming
- Messages
- Self diagnostics; identification of a failed module
- PID Control

Input Devices

- Transmitters
- Temperature Sensors
- Pressure Sensors
- Flow or Motor Status
- Sensor Wells

Output Devices

- Valves
- Actuators
- Control Relays

Surge and Transient Protection

Power Line

SD-01 Data

Provide General Data submittals;

Training course documentation: Training course documentation shall include three manuals. Documentation shall include an agenda, defined objectives for each lesson and detailed description of the subject matter of each lesson.

Service organization: Qualified service organization list shall include the names and telephone numbers of organizations qualified to service the HVAC control systems.

SD-04 Drawings

Control System Schematic
Ladder Diagrams
Component Wiring Diagrams
Terminal Strip Diagrams
Design Data
As-Built Drawings

Drawings shall be prepared by use of Autocad Version 2002 (Autodesk Inc., CADD Software). As-Built Drawings shall be provided in drawing file format (.DWG) on double-sided, 2 Mb capacity, 3.5 inch diskettes or compact discs.

Control System Schematic

Provide control system schematic that includes the following:

Location of each input and output device

Flow diagram of each HVAC component, for instance flow through coils, fans, dampers

Name or symbol for each component such as V-1, M-2, T-1 for a valve, damper motor, and temperature sensor, respectively

Setpoints

Sensor range

Actuator range

Valve and damper schedules and normal position

Switch points on input switches

Written sequence of operation for each schematic

Schedule identifying each sensor and controlled device with the following information:

Software point name

Point type (AO, AI, DO, DI)

Point range (4 to 20 ma, 100 or 1000 ohm platinum RTD, 10,000 ohm thermistor)

Digital controller number to which the point connects.

Electrical Equipment Ladder diagrams

Submit diagrams showing electrical equipment interlocks, including voltages and currents.

Component Wiring Diagrams

Submit a wiring diagram for each type of input device and each type of output device. Diagram shall show how the device is wired and powered; showing typical connections at the digital controller and each power supply, as well as at the device itself. Show for all field connected devices, including, but not limited to, control relays, motor starters, electric or electronic actuators, and temperature, pressure, flow, proof, and humidity sensors and transmitters.

Terminal Strip Diagrams

Submit a diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.

Design Data

Temperature sensor accuracy

Temperature sensor stability

Submit test data demonstrating the following installed components will meet specification requirements.

Temperature Sensor Accuracy

Submit manufacturer specification of temperature sensor accuracy. Literature shall make clear sensor accuracy as specified.

Temperature Sensor Stability

Provide manufacturer specification of five year stability of RTDs and thermistors. Literature shall make clear sensor

stability as specified.

As-Built Drawings shall be submitted for all Controls and Accessories providing current factual information including deviations and amendments to the drawings.

SD-19 Operation and Maintenance Manuals

Contractor shall submit 4 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality.

Sensor and Control Components Manual: Submit detailed information of control system components external to the field installed digital controllers. Submit manufacturers' manuals detailing specifications, installation, maintenance, and calibration.

Operator's Manual: Submit the following information necessary to operate the direct digital control system.

Initializing Digital Controllers: Include documentation for set-up, from scratch, of the digital controllers. Include shop drawings showing cable connections, dip switch settings, and each equipment setting essential for proper operation of each digital controller. Include information necessary to initialize the digital controllers to a point they can accept control programs from a computer.

Uploading and Downloading Controller Software: Include step by step procedures for uploading and downloading control programs to/from digital controllers and workstation computer or by directly connected computer.

Point Set-up Documentation: Include complete documentation for the software setup, on a controller by controller basis, of every physical and virtual point. This includes point name, point type, point description, point location (if a physical I/O point), span, offset, slope, intercept, change of value, and any other characteristic used to define each physical and virtual point.

Scheduling and Set Point Adjustment: Include step-by-step procedures for making set point and equipment scheduling changes through workstation software or by direct connection to a digital controller.

Controller Diagnostics: Include documentation describing running and analyzing controller diagnostics. Define LED indicators.

Alarms and Messages: List alarms and messages programmed into the digital controllers. Describe probable causes of all alarms.

PID Loop Tuning: Include PID loop tuning procedures for the control system.

1.4 RELATED REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.5 STORAGE

Stored products shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 QUALITY ASSURANCE

1.6.1 Standard Products

Material and equipment shall be standard products of manufacturers regularly engaged in the manufacturing of such product, using similar materials, design and workmanship.

The equipment items shall be supported by a service organization.

1.6.2 Nameplates and Tags

Nameplates bearing legends as shown and tags bearing device unique identifiers as shown shall be engraved or stamped. Nameplates shall be permanently attached to HVAC control panel doors.

For each field mounted piece of equipment, not in a finished area, a plastic or metal tag with equipment name and point identifier shall be attached.

1.6.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.6.4 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, and shall furnish all work necessary to meet such conditions.

1.6.5 Modification of References

The advisory provision in ASME B31.1 and NFPA 70 shall be considered

mandatory. Substitute the word "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

PART 2 PRODUCTS

2.1 DDC SYSTEM

Provide a DDC system as a distributed control system. The system shall have stand-alone digital controllers. All new digital controllers shall be compatible with Siemens Apogee 3.4.

Provide an operator programmable system, based on the user applications, to perform closed-loop, modulating control of building equipment. Connect all digital controllers through the communication network to share common data.

Provide an RS-232 or RS-485 communication link to the telephone backboard utilizing a single twisted wire pair, for future connection by the Government.

The new DDC control system shall be fully compatible with one of the existing Energy Management Control Systems (EMCS) listed following:

OPERATOR WORKSTATION SOFTWARE

Siemens Apogee Version 3.4

The above listed system is located in the EMCS office in Building 1268, Langley Research Center. The system has its own dedicated graphical workstation.

The Contractor shall provide all necessary software and shall configure a Government-owned laptop computer to communicate with each controller through the communication port to configure and troubleshoot the device.

The Contractor shall provide all software upgrades to the operator's workstation needed in order to communicate with the building management system through the LAN.

All cables, additional software, and adapters necessary for these communication connections shall be provided by the Contractor.

The Contractor shall provide the most current field interface software and configure a Government-owned computer.

The new DDC control system shall not use any integrators, gateways, or interfaces in order to be fully compatible with one of the existing EMCS.

Provide the quantity of digital controllers indicated on the drawings that will perform required climate control, energy management, and alarm functions. All material used shall be currently in production.

2.1.1 Direct Digital Controllers

DDC hardware shall be UL 916 rated. For Work Package No. 2, the existing Siemens SCU-3 controller shall be used.

2.1.1.1 Distributed Control

Apply digital controllers in a distributed control manner.

2.1.1.2 Input/Output (I/O) Point Limitation

Total number of I/O hardware points connected to a single stand-alone digital controller shall not exceed 36.

2.1.1.3 Environmental Operating Limits

Provide digital controllers that operate in environmental conditions between 32 and 120 degrees F.

2.1.1.4 Stand-Alone Control

Provide stand-alone digital controllers.

2.1.1.5 Memory

Provide sufficient memory for each controller to support required control and communication functions.

Memory Protection: Programs residing in memory shall be protected either by using EEPROM or battery. The backup power source shall have sufficient capacity to maintain volatile memory in event of an AC power failure for a minimum of seventy-two hours.

2.1.1.6 Inputs

Provide input function integral to the direct digital controller. Provide input type as required by the DDC design.

Analog Inputs: Allowable input types are three wire 100 ohm or higher platinum RTDs, stable 10,000 ohm thermistors, and 4 to 20 milliamps (mA). Thermistor and direct RTD inputs must have appropriate conversion curves stored in controller software or firmware. Analog to digital (A/D) conversion shall be a minimum of 10 bit resolution.

Digital Inputs: Digital inputs shall sense open/close, on/off, or other two state indications.

2.1.1.7 Outputs

Provide output function integral to the direct digital controller. Provide output type as required by the DDC design.

Analog Outputs: Provide controllers with a minimum output resolution of 8 bits. Output shall be 4 to 20 mA.

Digital Outputs: Provide contact closure with contacts rated at a minimum

of 1 ampere at 24 volts.

2.1.1.8 Proportional Integral Derivative (PID) Control

Provide controllers with proportional, proportional plus integral, and proportional plus integral plus derivative control capability. Terminal controllers are not required to have the derivative component.

2.1.1.9 Communications Ports

Controller-to-Controller Local Area Network (LAN) Communications Ports: Controllers in the building DDC system shall be connected in a communications network. Network may consist of more than one level of local area network and one level may have multiple drops. Communications network shall permit sharing between controllers of sensor and control information, thereby allowing execution of dynamic control strategies and coordinated response to alarm conditions. Minimum baud rate shall be 9600 Baud.

On-Site Interface Ports: Provide a RS-232 communications port for each digital controller that allows direct connection of a computer through which the controller may be fully interrogated. Controller access shall not be limited to access through another controller. On-site interface communication ports shall be in addition to the communications port(s) supporting controller to controller communications. Communication rate shall be 9600 Baud minimum. Every controller on the highest level LAN shall have a communications port supporting direct connection of a computer; a hand held terminal port is not sufficient. By connecting a computer to this port, every controller in the direct digital control system shall be able to be fully interrogated and programmed. The following operations shall be available: downloading and uploading control programs, modifying programs and program data base, and retrieving or accepting trend reports, status reports, messages, and alarms.

Remote Work Station Interface Port: Provide one additional direct connect computer port in each DDC system for permanent connection of a remote operator's work station, unless the workstation is a node on the LAN. All operations possible by directly connecting a computer to a controller at the highest level LAN shall be available through this port.

EMCS Interface Port: Provide one additional direct connect computer port in each DDC system for permanent connection to the EMCS. All operations possible by directly connecting a computer to a controller at the highest level LAN shall be available through this port.

2.1.1.10 Digital Controller Cabinet

Each digital controller cabinet shall protect the controller from dust and be rated NEMA 1, unless specified otherwise. Controller cabinets, or enclosures the controller is mounted in shall be lockable.

2.1.1.11 Main Power Switch

Each controller shall have a main power switch for isolation of the

controller from AC power. The switch shall be protected from tampering within the DDC cabinet. Controller shall be labeled to indicate which panel circuit number disconnects the controller.

2.1.2 Terminal Control Units (TCU)

TCUs shall be manufactured by the same company as the digital controllers. TCUs shall automatically start-up on return of power after a failure, and previous operating parameters shall exist or shall be automatically downloaded from a digital controller on a higher level LAN.

TCUs do not require an internal clock, if they get time information from the digital controller.

2.1.3 DDC Software

Software shall reside in the digital controllers and perform control sequences.

2.1.3.1 Sequence of Control

Provide, in the digital controllers, software to execute the sequence of control.

2.1.3.2 Database Modification

Provide software to modify the control program database. Database modification shall be accomplished through a locally connected computer and through connection to the EMCS. Database modification shall be accomplished without having to make changes directly in line-by-line programming. All points and logic routines shall be labeled, tagged, or named in the software. All sequences in routines shall be labeled with notes or expressions to clearly show the logic. Alternatively, block programming languages shall provide for modification of these database parameters in fill-in-the-blank screens. The following database parameters shall be modifiable by fill-in-the-blank screens:

- Setpoints
- Deadband limits and spans
- Reset schedules
- Switchover points
- PID gains and time between control output changes
- Time
- Timed local override time
- Occupancy schedules
- Holidays
- Alarm points, alarm limits, and alarm messages
- Point definition database
- Point enable, disable, and override
- Trend points, trend intervals, trend reports
- Analog input default values
- Passwords
- Communications parameters including network and telephone communications setups

2.1.3.3 Differential

Where equipment is started and stopped or opened and closed in response to some analog input such as temperature, pressure, or humidity, include a differential for the control loop to prevent short cycling of equipment.

2.1.3.4 Motor and Flow Status Delay

Provide an adjustable delay between when a motor is commanded on or off and when the control program looks to the motor or flow status input for confirmation of successful execution of the command.

2.1.3.5 Runtime Accumulation

Provide resettable run time accumulation for each controlled electrical motor.

2.1.3.6 Timed Local Override

Provide user definable adjustable run time for each push of a momentary contact timed local override. Pushes shall be cumulative with each push designating the same length of time. Provide a user definable limit on the number of contact closures summed before the contact closures are ignored. Timed local overrides are to be disabled during occupancy periods.

2.1.3.7 Time Programs

Provide programs to automatically adjust for leap years, year 2000 requirements, and make daylight savings time and standard time adjustments.

A time of day schedule shall be created for each piece of equipment.

2.1.3.8 Scheduling

Each control output point shall be schedulable and its operation based on time of day, day of week, and day of year. Output points may be associated into groups. Each group may be associated with a different schedule. Changing the schedule of a group shall change the schedule of each point in the group. Points may be added to and deleted from groups. Groups may be created and deleted by the operator.

Provide capability that will allow current schedules to be viewed and modified in a seven day week format. When control program does not automatically compute holidays, provide capability to allow holiday schedules to be entered one full year at a time.

2.1.3.9 Point Override

Through software, I/O and virtual points shall be able to be overridden and commanded to any allowable value.

2.1.3.10 Alarming

I/O points and virtual points shall be alarmable and may be enabled and disabled for every point. Alarm limits shall be adjustable on analog points. Controllers connected to an external communications device such as a printer, terminal, or computer, shall download alarm and alarm message when alarm occurs. Otherwise, alarms will be stored and automatically downloaded when a communications link occurs. The following conditions shall generate alarms:

- a. Motor is commanded On or Off, but the motor status input indicates no change
- b. Temperature or pressure strays outside selectable limits
- c. An analog input takes a value indicating sensor failure
- d. A module is "dead" to the LAN
- e. A power outage occurs

2.1.3.11 Messages

Messages shall be operator defined and assigned to alarm points. Messages shall be displayed when a point goes into alarm.

2.1.3.12 Trending

DDC system shall have the capability to trend I/O and virtual points. Points may be associated into groups. A trend report may be set up for each group. The period between logging consecutive trend values shall range from one minute to 60 minutes at a minimum. Trend data type shall be selectable as either averages over the logging period or instantaneous values at the time of logging. The minimum number of consecutive trend values stored at one time shall be 30 per variable. When trend memory is full, the most recent data shall overwrite the oldest data. Trend data shall be capable of being uploaded to computer. Trend data shall be available on a real time basis; trend data shall appear either numerically or graphically on a connected computer's screen as the data is being processed from the DDC system data environment. Trend reports shall be capable of being uploaded to computer disc and archived.

2.1.3.13 Status Display

Current status of I/O and virtual points shall be displayed on command. Points shall be associated into functional groups, such as all the I/O and virtual points associated with control of a single air handling unit, and displayed as a group, so the status of a single mechanical system can be readily checked. A group shall be selectable from a menu of groups having meaningful names; such as AHU-4, Second Floor, Chiller System, and other such names.

2.1.3.14 Diagnostics

Each controller shall perform self-diagnostic routines and provide messages to an operator when errors are detected. DDC system shall be capable of

recognizing a nonresponsive module on a LAN. The remaining, responsive modules on a LAN shall not operate in a degraded mode.

2.1.3.15 Power Loss

In event of a power outage, each controller shall assume a disabled status and outputs shall go to a user definable state. Upon restoration of power, DDC system shall perform an orderly restart, with sequencing of outputs.

2.1.3.16 Program Transfer

Software shall download control programs and database from a locally connected computer and the EMCS to controllers and upload programs and database to local computer and EMCS from controllers. Every digital controller in the DDC system shall be capable of being downloaded and uploaded through a single controller on the highest level LAN.

2.1.3.17 Password Protection

Provide at least three levels of password protection to the DDC system permitting different levels of access to the system.

2.1.4 Workstation

The workstation computer is an existing Government owned graphical workstation located in the EMCS office in Facility 1268. The workstation shall be capable of accessing all controllers, including TCUs, in the DDC system.

2.1.4.1 Software

Workstation software shall be supported by the DDC system manufacturer and configured to operate in accordance with the DDC system specifications. Operations shall be menu selected. Menu selections shall be made with a mouse.

- a. Menu System: Menu system shall allow an operator to select a particular function or access a particular screen through successive menu penetration.
- b. Controller Data Base Modification: The workstation software shall be an interface for performing capabilities specified in paragraph entitled, "DDC Software" in this section, and available through direct connection of a computer to a digital controller. Database modification shall require only that an operator "fill in the blank" for that parameter on a screen requesting the information in plain language. Database modifications shall be automatically downloaded to the appropriate controllers at operator request.
- c. Program modification: For systems using a line-by-line programming language, provide an off-line text editor, similar to a BASIC program editor, permitting modification of controller resident control programs. For systems using block programming languages, provide a capability for linking blocks together to

create new programs or modify existing programs. Program modifications shall be automatically downloaded to the appropriate controllers at operator request.

2.1.5 Panel Mounted Display and Keypad

Provide panel mounted displays and keypads connected to each digital controller to communicate with the digital controllers.

2.2 SENSORS AND INPUT HARDWARE

2.2.1 Field Installed Temperature Sensors

2.2.1.1 Resistance Temperature Detectors (RTDs)

Provide RTD sensors with 1000 ohm or higher platinum elements that are compatible with the digital controllers. Sensors shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degrees F cumulative. Direct connection of RTDs to digital controllers, without transmitters, is preferred provided controller supports direct connection of RTDs. When RTDs are connected directly to the controller, keep lead resistance error to 0.25 degrees F or less. Provide 3 wire sensing circuits to not exceed the 0.25 degrees F lead resistance error. Total error for a RTD circuit shall not exceed 0.5 degrees F, which includes sensor error, lead resistance error or 4 to 20 milliampere transmitter error, and analog to digital (A/D) conversion resolution error. Provide 18 gage twisted and shielded pair cable for both direct connected RTDs and transmitters.

Provide 4 to 20 milliampere transmitters for RTDs where digital controllers do not support direct connection of RTDs to controllers; and/or do not meet temperature resolution requirement of 0.25 degrees F.

2.2.1.2 Thermistors

Precision thermistors may be used in temperature sensing applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degrees F or less between the range of 32 to 150 degrees F. Sensor manufacturer shall utilize 100 percent screening to verify accuracy. Thermistors shall be pre-aged, and inherently stable. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. Sensor element and leads shall be encapsulated. Bead thermistors are not allowed. A/D conversion resolution error shall be kept to 0.1 degrees F. Total error for a thermistor circuit shall not exceed 0.5 degrees F, which includes sensor error and digital controller A/D conversion resolution error. Provide thermistor and digital controller manufacturer documentation and the Contractor's engineering calculations which support the proposed thermistor input circuit having a total error of 0.5 degree F or less. Provide 18 gage twisted and shielded cable for thermistors.

2.2.1.3 Temperature Sensor Details

Immersion Type: Three inches and 6 inches where shown total immersion for use with sensor wells, unless otherwise indicated.

Sensor Wells: Brass and stainless steel materials; provide thermal transmission material compatible with the immersion sensor. Provide heat-sensitive transfer agent between exterior sensor surface and interior well surface.

Outside Air Type: Provide element with sunshade to minimize solar effects. Mount element at least 3 inches from building outside wall. Sunshade shall not inhibit the flow of ambient air across the sensing element. Shade shall protect sensing element from snow, ice, and rain.

2.2.2 Transmitters

Transmitters shall have 4 to 20 mA output linearly scaled to the temperature, pressure, humidity, or flow range being sensed. Transmitter shall be matched to the sensor, factory calibrated, and sealed. Total error shall not exceed 0.1 percent of 20 milliampere (0.02 milliampere) at any point across the 4 to 20 mA span. Supply voltage shall be 24 volts ac or dc. Transmitters shall have noninteractive offset and span adjustments. For temperature sensing, transmitter stability shall not exceed 0.05 degrees C a year.

2.2.2.1 Spans and Ranges

Transmitter spans or ranges shall be the following and shall be suitable for the application:

a. Temperature:

1. 50 degrees F span: Room, chilled water, cooling coil discharge air, return air sensors

b. Pressure:

1. 0 to 60 PSI differential: Pump differential pressure

2.2.3 Pressure Transmitters

Provide integral pressure transducer and transmitter. Output of pressure instrument shall be a 4 to 20 milliampere signal proportional to the pressure span. Span shall be as specified. Accuracy shall be 1.0 percent. Linearity shall be 0.1 percent. Supply voltage shall be 24 V dc. Transmitter shall meet specified requirements.

2.2.4 Input switches

2.2.4.1 Differential Static Pressure Switch

Provide diaphragm type differential static pressure switches for binary (two-position) operation as specified in sequence of operation. Devices shall withstand pressure surges up to 150 percent of rated pressure. Contacts shall be single pole double throw, and switch may be wired for

normally open or normally closed operation. Trip set point shall be adjustable. Pressure switch shall be sized so that operating pressure trip point is approximately midpoint of pressure switch adjustable range. Repetitive accuracy shall be 2 percent.

2.2.4.2 Induced Current Operated Solid State Switches

Provide adjustable ranging to monitor continuous loads up to 200 amperes. Switch shall indicate whether it is normally open or normally closed. Limit off-state leakage to 2 milliampere or less.

2.2.4.3 Timed Local Override

Provide momentary contact push button override with override time set in controller software. Provide to override DDC time of day program and activate occupancy program for assigned units. Upon expiration of override time, the control system shall return to time-of-day program. Time interval for the length of operation shall be software adjustable and shall expire unless reset.

2.3 OUTPUT HARDWARE

2.3.1 Valves

2.3.1.1 Valve Assembly

Valves shall have stainless steel stems. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv. Class 125 copper alloy valve bodies shall conform to ASME/ANSI B16.5 as a minimum. Cast iron valve components shall conform to ASTM A 126 Class B or C as a minimum.

2.3.1.2 Butterfly Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service and for modulation to the fully closed position, with noncorrosive discs, stainless steel shafts supported by bearing, and ethylene propylene dipolymer (EPDM) seats suitable for temperatures from minus 20 degrees F to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator.

2.3.1.3 Two-Way Valves/Three-Way Valves

Two-way modulating valves shall have equal percentage characteristics.

Three-way valves shall have equal percentage characteristics.

2.3.1.4 Valves for Water Service

Bodies for valves 1-1/2 inches and smaller shall be brass or bronze. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze or iron. Bodies for valves 2 inches and smaller shall have threaded ends. Bodies for valves 2-1/2 inches and larger shall have flanged-end

connections. Internal valve trim shall be brass or bronze except that valve stems may be Type 316 stainless steel. Water valves shall be sized for a 5 psi differential through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow. Valves 4 inches and larger shall be butterfly valves.

2.3.2 Actuator

2.3.2.1 Electric

Actuator shall be compatible with existing valves. Contractor shall field verify valve and model.

Provide gear type electric operators with spring return or power return so that, in the event of power failure, actuators shall fail safe in either the normally open or normally closed position as specified. Actuators shall be quiet operating and function properly within the range of 85 to 110 percent of the motive power. Provide a minimum of one actuator for each damper. When operated at rated voltage, each operator shall be capable of delivering the torque required for continuous uniform movement of the valve or damper and shall have end switch to limit travel or shall withstand continuous stalling without damage. Operators shall function properly with range of 85 to 110 percent of line voltage. Provide gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch pounds. Provide hardened steel running shafts in sleeve bearing of copper alloy, hardened steel, nylon, or ball bearing. Enclose operators and gear trains totally in dustproof housings with rigid conduit connections. Provide two-position operators of the single direction, spring return, or reversing type. Provide proportioning operators capable of stopping at all points in the cycle and starting in either direction, from any point. Provide reversing and proportioning operators with limit switches to limit travel in either direction unless operator is stall type. Equip valve operators with a force limiting device such as spring yield so that, when in a relaxed position, device shall maintain a pressure on valve disc equivalent to system pressure at valve. Provide reversible shaded pole, split capacitor, synchronous, or stepper type electric motors.

2.3.3 Output Switches

2.3.3.1 Control Relays

Control relays shall be double pole, double throw (DPDT), UL listed, with contacts rated to the application, and enclosed in a dustproof enclosure. Equip with a light indicator which is lit when coil is energized and is off when coil is not energized. Relays shall be socket type, plug into a fixed base, and be replaceable without need of tools or removing wiring.

All relays and auxiliary relays shall be labeled as to their purpose.

2.4 ELECTRICAL POWER AND DISTRIBUTION

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Provide a source of 120 volts or less, 60 hz, two-pole, three wire with ground. Devices shall be UL listed or FM approved.

2.4.1 Transformers

Transformers shall conform to UL 506. Provide a fuse cutout on the secondary side of the transformer.

2.4.2 Power Line Surge Protection

Surge suppressors shall be external to digital controller, and shall be installed on all incoming AC power. Surge suppressor shall be rated by UL 1449, and have clamping voltage ratings below the following levels:

Normal Mode (Line to Neutral): 350 Volts

Common Mode (Line to Ground): 350 Volts

2.4.3 Wiring

Provide complete electric wiring for temperature control apparatus, including wiring to transformer primaries. Use multiconductor cable for concealed accessible locations only. Provide circuit and wiring protection as required by NFPA 70. Protect exposed wiring from abuse and damage.

All control wiring shall be installed in conduit.

2.4.3.1 AC Control Wiring

Control wiring for 24 V circuits shall be copper conductor, Teflon insulated with overall Teflon jacket, air plenum rated, and non-conduit cable.

Wire size shall be in accordance with the controls system manufacturer's recommendations.

2.4.3.2 Wiring (Direct Digital Controls and Communications)

Wiring shall be single or multiple twisted pair with 100 percent aluminum foil shield, tinned stranded copper conductor, Teflon insulated with overall Teflon jacket, air plenum rated, and non-conduit cable.

Wire size shall be in accordance with the controls system manufacturer's recommendations.

Shield shall be grounded with 20 AWG stranded, tinned copper drain wire.

All communication wiring trunks entering and leaving controllers shall be labeled.

Labels shall identify trunk wiring both entering and leaving controllers by direction.

2.5 FIRE PROTECTION DEVICES

Provide smoke detectors in return and supply air ducts on downstream side of filters in accordance with NFPA 90A, except as otherwise indicated. Provide UL listed or FM approved detectors for duct installation. Duct smoke detectors as indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation under supervision of competent technicians regularly employed in the installation of DDC systems. Provide components for a complete and operational DDC system.

Run schedules and setpoints for all equipment shall be set by the Contractor as instructed in the field by the Contracting Officer or Contracting Officer Technical Representative.

3.1.1 Wiring Criteria

Input/output identification: Permanently label each field wire, cable, or pneumatic tube at each end with the identification specified.

Grounding: Ground controllers and cabinets to a good earth ground. Grounding of the green ac ground wire at the breaker panel alone is not adequate. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end.

The Contractor is responsible for correcting all associated ground loop problems.

3.1.2 Digital Controllers

Do not divide control of a single mechanical system such as an air handling unit, boiler, chiller, or terminal equipment between two or more controllers. A single controller shall manage control functions for a single mechanical system. It is permissible to manage more than one mechanical system with a single controller.

Provide digital control cabinets that protect digital controller electronics from dust, in accordance with the contract drawings.

Provide a main power switch at each highest level LAN digital controller within controller cabinet.

No multiplexing of points is allowed.

Each controller shall be labeled with the panel and circuit number of the 120 volt circuit supplying the device.

3.1.3 Temperature Sensors

Provide temperature sensors in locations to sense the appropriate condition. Provide sensor where they are easy to access and service

without special tools. Calibrate sensors to accuracy specified. In no case will sensors designed for one application be installed for another application (such as replacing a duct sensor with a room sensor).

3.1.3.1 Immersion Temperature Sensors

Provide thermowells for sensors measuring temperatures in liquid applications or pressure vessels. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to effect proper flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermowells with thermal transmission material within the well to speed the response of temperature measurement. Provide wells with sealing nuts to contain the thermal transmission material.

Each room temperature sensor shall be labeled with proper address of the controller with which it is connected.

3.1.4 Pressure Sensors

3.1.4.1 Differential Pressure

General: Install pressure sensing tips in locations to sense appropriate pressure conditions.

3.1.5 Control Drawings

Provide 4 sets of as-built drawings after installation is complete. The drawings shall also be copied onto double-sided, 2 MB capacity, 3.5-inch diskettes and submitted to the Government.

3.2 ADJUSTMENTS

Calibrate instrumentation and controls and verify the specified accuracy using test equipment with a test equipment accuracy. Adjust controls and equipment to maintain conditions indicated, to perform functions indicated, and to operate in the sequence specified.

3.3 TRAINING

Provide 3 copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the DDC system supplied. The Contractor shall instruct the Government's designated representatives in these procedures during the startup and test period. The duration of the instruction period shall be no less than four 4-hour sessions during normal working hours.

3.4 CALIBRATION AND ADJUSTMENTS

After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the DDC system.

3.5 ACCEPTANCE PROCEDURE

Upon completion of the calibration, Contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Contractor shall be responsible for generating all software and entering all data necessary to perform the sequence of control and specified software routines.

3.6 COMMISSIONING PROCEDURE

The Contractor shall furnish all personnel and materials necessary for final systems checkout. The Contracting Officer or the Contracting Officer Technical Representative shall be present to observe and verify the commissioning procedure.

The Contractor shall demonstrate operation of the following system capabilities and components in the presence of the Contracting Officer or the Contracting Officer Technical Representative:

Provide a spreadsheet of the listing of all I/O points. The listing shall include the project name as its title and the date. The point definition shall include the description, location, signal type and purpose (control or monitor) of each point.

Verify correct readings and operation of all physical analog I/O points by comparing actual parameter to remote indication as displayed by the system video monitor. All output points shall be exercised and checked for proper operation over its full range of operation and observing for correct response at the controlled equipment.

Exercise all physical digital I/O points for proper operation. All input points shall be checked with an ohmmeter for continuity and output points shall be checked for a dynamic response of the electromechanical device.

Verify that the building automation system algorithms are operating as described in the "Sequence of Control" portion of this section of the specifications.

Verify auxiliary relays are properly identified with labels, as to their purpose.

Verify all room temperature sensors are labeled with the proper address of the corresponding controller.

3.7 SEQUENCE OF OPERATION

The sequence of control shall be as indicated on the drawing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS (Not Applicable)
- 1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS
- 1.4 CODES AND STANDARDS
- 1.5 COORDINATION
- 1.6 APPROVAL REQUIREMENTS
- 1.7 PREVENTION OF CORROSION

PART 2 PRODUCTS

- 2.1 IDENTIFICATION PLATES
- 2.2 WARNING SIGNS
- 2.3 ANCHOR BOLTS
- 2.4 PAINTING

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 PAINTING APPLICATION
- 3.3 IDENTIFICATION PLATE INSTALLATION
- 3.4 EQUIPMENT PADS
- 3.5 CUTTING AND PATCHING
- 3.6 DAMAGE TO WORK
- 3.7 CLEANING
- 3.8 FIELD TESTING AND TEST EQUIPMENT

-- End of Section Table of Contents --

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123 (2000) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel Products

FEDERAL SPECIFICATIONS (FS)

FS W-J-800 (Rev F) Junction Box: Extension, Junction
Box; Cover, Junction Box (Steel, Cadmium,
or Zinc-Coated)

FEDERAL STANDARDS (FED-STD)

FED-STD 595 (Rev B) Colors Used in Government
Procurement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA Z 535 (1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-05 (1997) Electrical Construction Materials
Directory

1.2 SUBMITTALS (Not Applicable)

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), Inc., the label of, or listing with re-examination, in UL-05 will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in contact shall be protected by approved fittings, barrier

material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations and cadmium-plated in conformance with FS W-J-800 for interior locations.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be 3-layer black-white-black, engraved to show white letters on a black background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled.

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each Motor Control center and each individual cubicle. Identification plates shall designate the function and rating of the equipment, unit number and the electrical circuit feeder source and load. Spare Motor Control Center cubicles shall be provided with blank identification plates. Plate designations and load description shall be as indicated on MCC designation schedule in contract drawings.

Example for MCC main identification plate:

MOTOR CONTROL CENTER A-MCC-A
480/277 Volt 3Ø, 4W, 60 Hz
Fed from 480 volt Unit Substation "NA1"

Example for MCC individual cubicle identification plate:

MCC UNIT 1A

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each electrical equipment connection. Identification plates shall designate the function and rating of the equipment, unit number and the electrical circuit feeder source.

Example for AHU-1 unit identification plate:

AHU-1
480/277 Volt, 3Ø, 4W, 60 Hz
Fed from A-MCCA-4A

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each electrical equipment connection. Identification plates shall designate the function and rating of the equipment, unit number and the electrical

circuit feeder source.

Example for Chiller No. 6 unit identification plate:

CHILLER #6R

480/277 Volt 3 Phase, 4W, 60 Hz

Fed from B-MCCF-3C

2.2 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards, 29 CFR 1910.145.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to NEMA Z 535.

2.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.4 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside.

ITEM	FINISH COLOR
Motor Starter/Switchgear	No. 61 gray (FED-STD 595)
Safety Switches	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted with one coat of corrosion inhibitive metal primer and two coats of enamel paint. Paint color shall match the existing wall finish, unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.

Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red. Color shall conform to FED-STD 595, Color 11105.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be constructed with a minimum 4-inch margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install the work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field Testing specified in Division 16 electrical specification shall be made with test equipment specially designed and calibrated for this purpose. Test equipment used shall be calibrated and certified by the approved testing laboratory. Date of last calibration and certification shall not be more than 90 calendar days old at the time of field testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16124

MEDIUM VOLTAGE CABLE

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
- 1.3 GENERAL REQUIREMENTS
- 1.4 SUBMITTALS
- 1.5 QUALIFICATIONS
- 1.6 CABLE VOLTAGE RATINGS
- 1.7 SHIPMENT

PART 2 PRODUCTS

- 2.1 CONDUCTORS
- 2.2 CABLE IDENTIFICATION
- 2.3 SINGLE-CONDUCTOR NONSHIELDED CABLES
 - 2.3.1 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 Pulling Cables in Conduits
 - 3.1.2 Splices and Terminations
- 3.2 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16124

MEDIUM VOLTAGE CABLE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 3 (2001) Standard Specification for Soft or Annealed Copper Wire

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS6 (1996; 6th Ed) Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69KV

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA WC 8 (1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

1.2 DEFINITIONS

Medium voltage power cables shall mean all cables rated above 600 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Certificates shall be provided for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be provided for the following items:

Single-Conductor Nonshielded Cables

Manufacturer's Catalog Data shall be provided for the following items:

Single-Conductor Nonshielded Cables

SD-09 Reports

Test Reports for the following shall be in accordance with the paragraph entitled, "Field Testing," of this section.

Dielectric Absorption Tests
High-Voltage Tests

SD-13 Certificates

Certificates of Compliance shall be provided for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

Conductor Resistance
High-Voltage
Mechanical Integrity
Bending Test
High-Voltage Time Test
Dielectric Power Loss
Qualifications of Cable Splicers

1.5 QUALIFICATIONS

Cable splicers performing splicing shall have 5 years experience in cable splicing and terminations.

1.6 CABLE VOLTAGE RATINGS

Medium-voltage power cables shall include multiple- and single-conductor cables rated as follows, phase-to-phase, for grounded and ungrounded neutral systems:

Cables rated 5,000 volts, 133 percent insulation ungrounded neutral, shall be used on 2,400/4,160-volt, three-phase, 60-hertz distribution systems.

1.7 SHIPMENT

Cable shall be shipped on reels such that the cable will be protected from mechanical injury. Each end of each length of cable shall be hermetically sealed and securely attached to the reel.

Minimum reel drum diameter shall be 14 times the overall diameter of the cable. A pulling eye shall be installed by the manufacturer for each length of cable supplied for installation in ducts, manholes, and utility tunnels.

PART 2 PRODUCTS

2.1 CONDUCTORS

Conductors shall be solid copper conforming to ASTM B 3.

2.2 CABLE IDENTIFICATION

Cables shall have a tape placed immediately under the lead sheath or outer jacket showing the name of the manufacturer, the year in which the cable was manufactured, and a unique number for identification purposes. Information shall be closely grouped on the tape at 1-foot intervals to permit complete identification.

2.3 SINGLE-CONDUCTOR NONSHIELDED CABLES

2.3.1 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

Single-conductor, ethylene-propylene-rubber-insulated, polyvinylchloride-jacketed, nonshielded cable shall conform to NEMA WC 8 and AEIC CS6.

PART 3 EXECUTION

3.1 INSTALLATION

Medium-voltage cables shall be installed in accordance with NFPA 70.

Cable shall be installed in conduit inside buildings.

3.1.1 Pulling Cables in Conduits

Medium-voltage cables shall be pulled into conduits with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.

Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

$$TM = 0.008 \times N \times CM$$

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular milss

Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a pulling eye.

Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.

Pulling eyes and cable grips shall be used together for nonmetallic sheathed cables to prevent damage to the cable structure.

Minimum bending radius shall be in accordance with the following:

<u>CABLE TYPE</u>	<u>MINIMUM BENDING RADIUS MULTI- PLIER TIMES CABLE DIAMETER</u>
RUBBER- AND PLASTIC-IN- SULATED CABLE WITH OR WITHOUT INTERLOCKED ARMOR	

Nonshielded cables

8

Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall be used only on lead-sheathed cables. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

Cables shall be pulled into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture. Nonleaded cables shall be sealed with rubber tape wrapped down to 3 inches from the cable end. Rubber tape shall be cover-wrapped with polyvinylchloride tape. Lead-covered cables shall be sealed with wiping metal making a firm bond with the end of the sheath or with a disk of lead fitted over the end and wiped to the sheath.

3.1.2 Splices and Terminations

Once a termination has been started by a worker, the same person shall complete that particular termination. Each termination shall be started and completed in one continuous work period.

Terminating of cables shall be expedited to minimize exposure and cable deterioration.

EPR insulated cable shall be fireproofed where exposed in switchgear.

Each cable end shall be supported by support members inside of starter, where applicable.

3.2 FIELD TESTING

Each shall be subjected to dielectric-absorption tests and high-voltage tests after the installation of high-voltage power cables has been completed, including splices, joints, and terminations, and before the cable is energized.

Test equipment, labor, and technical personnel shall be provided as necessary to perform the electrical acceptance tests.

Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

Each power cable shall first be given a full dielectric-absorption test with 5000-volt insulation-resistance test set. Test shall be applied for a long enough time to fully charge the cable. Readings shall be recorded every 15 seconds during the first 3 minutes of test and at 1 minute intervals thereafter. Test shall continue until three equal readings, 1 minute apart, are obtained. Minimum reading shall be 200 megohms at an ambient temperature of 68 degrees F. Readings taken at other than 68 degrees F ambient temperatures shall be corrected accordingly.

Results of the second dielectric-absorption test shall agree with the first test and shall indicate no evidence of permanent injury to the cable caused by the high-potential test.

Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words

"Final Test Report - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16145

STANDARD WIRING SYSTEMS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 CONDUITS, RACEWAYS, AND FITTINGS
 - 2.1.1 Rigid Conduit
 - 2.1.2 Electrical Metallic Tubing (EMT)
 - 2.1.3 Flexible Metallic Conduit
- 2.2 WIRE AND CABLE
 - 2.2.1 Building Wire
 - 2.2.2 Switchboard Wire
 - 2.2.3 Splices and Connectors
- 2.3 SAFETY SWITCHES
- 2.4 BOXES AND FITTINGS
 - 2.4.1 Pull and Junction Boxes

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 Installation of Rigid Metal Conduit
 - 3.1.2 Installation of EMT
 - 3.1.3 Installation of Flexible Metallic Conduit
- 3.2 INSTALLATION OF WIRING
- 3.3 SAFETY SWITCHES
- 3.4 BOXES AND FITTINGS
- 3.5 IDENTIFICATION PLATES
- 3.6 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16145

STANDARD WIRING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated

ANSI C80.3 (1994) Electrical Metallic Tubing - Zinc-Coated

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 173 (2001) Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

ASTM B 3 (2001) Standard Specification for Soft or Annealed Copper Wire

ASTM D 2301 (1999) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA FB 1 (1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

NEMA KS 1 (2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1 (2000) UL Standard for Safety - Flexible Metal Conduit

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

UL 1581	(1997; 3rd Ed) UL Standard for Safety - Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 486C	(2000) UL Standard for Safety Splicing Wire Connectors
UL 50	(1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment
UL 514A	(1996; 9th Ed) UL Standard for Safety - Metallic Outlet Boxes
UL 514B	(1997) UL Standard for Safety Fittings for Conduit and Outlet Boxes
UL 6	(2000) UL Standard for Safety - Rigid Metal Conduit
UL 797	(2000) UL Standard for Safety - Electrical Metallic Tubing

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-09 Reports

Test Reports shall be submitted for Standard Wiring Systems in accordance with the paragraph entitled, "Field Testing," of this section.

PART 2 PRODUCTS

2.1 CONDUITS, RACEWAYS, AND FITTINGS

Conduit shall be 1/2-inch diameter minimum, except where specifically shown smaller on the contract drawings, and except for exposed switch leg runs.

Conduit, connectors, and fittings shall be approved for the installation of electrical conductors.

2.1.1 Rigid Conduit

Rigid steel, including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and ANSI C80.1. Steel fittings shall be galvanized by the hot-dip process.

Fittings for rigid steel conduit shall be threaded and shall conform to NEMA FB 1.

Gaskets shall be solid for fittings sized 1-1/2 inches and less. Conduit fittings with blank covers shall have gaskets except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland type, zinc-plated steel fittings. Crimp, spring, or setscrew type fittings are not acceptable. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors shall be the insulated-throat type, with a locknut. Fittings shall meet the requirements of NEMA FB 1.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall meet the requirements of UL 1.

Fittings for flexible metallic conduit shall meet the requirements of UL 514B, Type I box connector, electrical, Type III coupling, electrical conduit, flexible steel, or Type IV adapter, electrical conduit.

2.2 WIRE AND CABLE

Insulated current-carrying wire and grounding conductors shall be copper and shall conform to NFPA 70 and UL 1581. Wire bundles with cable ties shall be secured to the enclosure with sheet-metal screws. Self-sticking adhesive attachments are not acceptable.

2.2.1 Building Wire

Building wire for use in conduits, raceways, and wireways shall be single-conductor, 600-volt, heat- and moisture-resistant insulated wire suitable for use in wet or dry locations.

Conductors AWG No. 10 and smaller shall be solid round copper wire. Conductors AWG No. 8 and larger shall be standard concentric stranded copper wire. Conductors shall be not less than AWG No. 12, except that AWG No. 14 shall be stranded copper wire and shall be used for control wiring.

Building wire shall be Type THHN with insulation of PVC and nylon jacket, with a minimum temperature rating of 90 degrees C.

2.2.2 Switchboard Wire

Switchboard wire used for instrument and control wiring on the back of switchboards and hinged-front instrument panels shall be single-conductor, 600-volt, flame- and heat-resistant insulated wire not smaller than AWG No. 14 with a minimum temperature rating of 90 degrees C.

Conductors rigidly mounted on the back of switchboards and instrument panels shall be solid round, soft or annealed, copper wire conforming to ASTM B 3. Hinge connections shall be rope-lay-stranded copper conductors, Class H, conforming to ASTM B 173. All wires before stranding shall conform to ASTM B 3 for soft or annealed copper wire.

Switchboard wire shall be Type SIS with cross-linked thermosetting polyethylene insulation.

2.2.3 Splices and Connectors

Splices in building wire AWG No. 8 and smaller and multiple conductor cables shall be made with insulated metal twist-on connectors, Scotchlock, or equal, connectors or with indenter crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Splices in building wire AWG No. 8 and larger and single-conductor cables shall be made with indenter crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor. Splices in rubber-insulated neoprene-jacketed wire and cables shall be watertight.

Vinyl-plastic electrical insulating tape shall meet the requirements of ASTM D 2301. Where pressure-sensitive tape is used, the surface shall be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer shall be applied prior to taping.

Where indicated and for building wire AWG No. 8 and larger, terminations shall utilize screw-set pressure terminal lugs.

Where indicated, building wire AWG No. 10 and smaller shall be terminated in pre-insulated crimp ring lugs on terminal blocks.

Solid wiring shall be terminated with terminal blocks specifically designed for solid wire. Crimp type shall not be used on solid wire for termination.

Stranded wire shall use crimp insulated fork tongue type lugs for termination on terminal blocks.

2.3 SAFETY SWITCHES

Switches shall comply with NEMA KS 1.

Safety switches shall be the heavy-duty type with voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so

constructed that an external tool (screwdriver) must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch handle shall not be capable of being locked in the ON position.

Switches shall be the quick-make, quick-break type. Terminal lugs shall be approved by the manufacturer for use with copper conductors.

2.4 BOXES AND FITTINGS

Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 and UL 514A. Boxes that are exposed to the weather or that are in normally wet locations shall be cast-metal with threaded hubs. Surface-mounted boxes on interior walls shall be cast-metal. Boxes in other areas shall be cadmium-plated or zinc-coated sheet metal.

2.4.1 Pull and Junction Boxes

Pull and junction boxes shall be fabricated from carbon steel and shall conform to UL 50. Box dimensions and conduit connections shall conform to NFPA 70.

Boxes shall be welded construction with flat removable covers fastened to the box with machine screws. Seams and joints at corners or back edges of the box shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by other means such as continuous welding which provides a construction equivalent to integral flange construction.

Boxes intended for use in dry locations shall be sheet steel hot-dipped galvanized after fabrication conforming to UL 514A.

PART 3 EXECUTION

3.1 INSTALLATION

Power, control power, and special-service systems and all related components shall be installed in accordance with NFPA 70, and shall be enclosed in separate conduit or separate conduit systems.

Any run of electric metallic tubing (EMT), intermediate, or rigid conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting. Field bends shall be made in accordance with the manufacturer's recommendations, which normally require use of a one-size-larger bender than would be required for uncoated conduit. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed. Empty conduit shall have a pull rope installed.

Conduit shall be installed with a minimum of 3 inches of free air space separation from mechanical piping.

Conduit in finished areas shall be installed concealed. Conduit passing through masonry or concrete walls shall be installed in sleeves.

Conduit shall be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally. Galvanized pipe straps shall be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs shall not be used.

Conduit and boxes shall not be supported from T-bar ceiling wires.

Conduit connections to boxes and fittings shall be supported not more than 36 inches from the connection point. Conduit bends shall be supported not more than 36 inches from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports.

Conduit and raceway runs in or under concrete, in damp, corrosive, or outdoor locations, where subject to mechanical damage, or intended for conductors rated over 600 volts, shall be rigid steel conduit.

Insulated bushings with box connectors shall be provided on the open ends of conduit containing conductors. Insulated bushings shall be provided for conduits containing conductors AWG No. 4 or larger with an insulating ring an integral part of the bushing.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

Wire or cable shall not be installed in conduit until the conduit system is completed; the inner surfaces of conduit shall be clean and dry.

A nylon or polypropylene pull rope with a tensile strength not less than 130 pounds or a No. 14 AWG galvanized steel pull wire shall be installed in empty conduit.

3.1.1.1 Installation of Rigid Metal Conduit

Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

Ninety-degree bends of conduit with a diameter larger than 1 inch shall be made with factory-made elbows. Conduit elbows larger than 2-1/2 inches shall be long radius. Field-made bends and offsets shall be made with a hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing into firm electrical contact with

the box. Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts where required by NFPA 70 where insulating bushings are used, where bushings cannot be brought into firm contact with the box, and where indicated.

Conduit joints shall be made with tapered threads set firmly. Each length of conduit cut in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosion-inhibitive compound shall be used on conduit threads in exterior areas.

Conduit stubbed-up through concrete floors for connections to free-standing equipment except motor-control centers, cubicles, and other such items of equipment shall be provided with a flush coupling if the floor slab is of sufficient thickness; if not, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Installation of EMT

EMT shall be cut square and reamed to remove burrs and rough surfaces.

Field-made bends and offsets shall be avoided where possible but, where necessary, shall be made with a hickey or conduit-bending machine. Changes in direction of runs shall be made with symmetrical bends or metal fittings.

3.1.3 Installation of Flexible Metallic Conduit

Flexible metallic conduit shall be installed only in exposed, accessible locations in accordance with NFPA 70. A grounding green conductor shall be installed in all runs. Connections to motors and vibrating equipment shall be made with flexible metallic conduit.

3.2 INSTALLATION OF WIRING

Raceways shall be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems shall not occupy the same enclosure with light and power conductors or the same enclosure with each other. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring shall be continuous between components and/or terminal boards.

Phase conductors and the neutral conductor of each branch or feeder circuit shall be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel shall be the same length and size, shall have conductors of the same type of insulation, shall be terminated at both ends in a manner to ensure equal division of the total current among conductors, and shall have a separate neutral conductor in each conduit.

Sharing of a common neutral between single phase circuits, connected to different phases, shall not be permitted.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Conductors installed in heavy-wall rigid steel conduit and EMT shall have allowable current-carrying capacity and ampere ratings in accordance with NFPA 70. Larger-sized conductors shall be used to compensate for derating factors when more than three current-carrying conductors are installed in raceways and when conductors are installed in wet locations.

Conductors 600 volts and below shall be color coded in accordance with the following:

<u>CONDUCTOR</u>	<u>FIRE ALARM</u> <u>COLOR</u>	<u>120/208</u> <u>COLOR</u>	<u>480/277</u> <u>COLOR</u>
Phase A		Black	Brown
Phase B		Red	Orange
Phase C		Blue	Yellow
Neutral		White	White/Gray
Equipment Grounds		Green	Green
Control Wires	Red (Plenum Rated)		

Conductors up to and including AWG No. 6 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 6 shall have ends identified with colored plastic tape in outlet, pull, or junction boxes. Control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to UL 486C and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

Grounding shall be provided in accordance with NFPA 70. Noncurrent-carrying parts of electrical equipment shall be bonded and grounded together.

3.3 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall utilizing a minimum of four 1/4-inch bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 5 feet above floor level, when possible.

3.4 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Bonding jumpers shall be used around concentric or eccentric knockouts.

Approximate mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be as follows:

<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Switches for motor control	48 inches
Thermostats	66 inches

3.5 IDENTIFICATION PLATES

Red identification plates reading CAUTION: 480/277 VOLTS shall be provided in switch and outlet boxes containing 277- or 480-volt circuits. An identification plate marked DANGER: 480 VOLTS shall be provided on the outside of 480-volt enclosures. Identification plate shall use white lettering on a red laminated plastic.

Any equipment with externally powered wiring shall be marked with a laminated plaster nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

3.6 FIELD TESTING

After completion of the installation and splicing, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests as herein specified before the conductors are energized.

Necessary test equipment, labor, and personnel shall be provided by the Contractor to perform the tests, as herein specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Wire and cable in each voltage classification shall be completely isolated from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Insulation tests on circuits rated 480-volts shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be taken every minute until three equal and consecutive readings are obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Insulation tests on circuits rated 240 volts or less, with conductor sizes 2 AWG and larger, shall be conducted using a 500-volt insulation-resistance test set. Readings shall be taken after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. No conductor shall be energized until the installation is approved.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16225

MOTORS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS
- 1.4 DESIGN REQUIREMENTS

PART 2 PRODUCTS

- 2.1 EQUIPMENT
- 2.2 MOTOR TYPES
- 2.3 SIZES OF MOTORS
 - 2.3.1 Motors
 - 2.3.2 Electrically Driven Equipment
- 2.4 VOLTAGE RATINGS
- 2.5 TEMPERATURE RATING AND INSULATION
- 2.6 MOTOR HOUSINGS
- 2.7 MOTOR ENCLOSURES
- 2.8 SERVICE FACTOR
- 2.9 FACTORY TESTS

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 ALIGNMENT
- 3.3 ELECTRICAL TESTS

-- End of Section Table of Contents --

SECTION 16225

MOTORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 112 (1991) Standard Test Procedure for
Polyphase Induction Motors and Generators

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940/1 (1986) Mechanical Vibration - Balance
Quality Requirements of Rigid Rotors -
Part 1: Determination of Permissible
Residual Unbalance

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1 (1998) Motors and Generators

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for Motors consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted.

Manufacturer's Catalog Data shall be submitted for the following items:

Motors
Enclosures

SD-13 Certificates

Certificates of Compliance shall be submitted for the following tests showing conformance with the referenced standards contained in this section. Certified copies of previous test reports on identical motors may be submitted in lieu of factory test reports.

Efficiency
Power-Factor
Service Factor

1.4 DESIGN REQUIREMENTS

The following motor design data shall be provided prior to final turnover-number of motor rotor bars, Stator slots, rotational speed; number of cooling fan blades; RPM of motor; bearing manufacturer, bearing type, bearing style and number of balls/elements; number of commutator bars and commutator brushes; and SCR firing frequencies.

PART 2 PRODUCTS

2.1 EQUIPMENT

Design, fabrication, testing, and performance of motors shall be in accordance with NEMA MG 1 and ISO 1940/1.

Testing and performance of polyphase induction motors shall be in accordance with IEEE Std 112, Method B.

Efficiency labeling shall be in accordance with NEMA MG 1.

Allowable balance limits shall be in accordance with ISO 1940/1, Table 1

2.2 MOTOR TYPES

Induction motors with 5- to 250-horsepower (HP) rating shall be the energy-efficient type and efficiencies shall be as high as those shown below. Motor shall be marked to show the index letter, which shall be the letter shown or a letter that indicates a higher efficiency.

Energy Efficiency Chart

<u>HP</u>	<u>RPM</u>	<u>NEMA INDEX LETTER</u>	<u>MINIMUM EFFICIENCY</u>	<u>NOMINAL EFFICIENCY</u>
10 and below	3,600	G	86.5	88.5
	1,800	F	88.5	90.2
	1,200	F	88.5	90.2
15 and above	3,600	F	88.5	90.2
	1,800	E	90.2	91.7
	1,200	F	88.5	90.2

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Motors shall be of the following types:

1/3 HP and smaller, single phase - capacitor start

1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

Motors shall be designed for across-the-line starting and shall be designed with torque characteristics to carry the specified rated starting load.

Motors shall have factory-sealed ball bearings.

2.3 SIZES OF MOTORS

2.3.1 Motors

Motors shall be a sufficient size for the duty to be performed and shall not exceed the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.3.2 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, adjustments shall be made to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed, at no additional cost to the Government. Control and protective devices shall be in accordance with Section 16286, "Overcurrent Protective Devices."

2.4 VOLTAGE RATINGS

Motors shall have the following minimum voltage ratings:

MOTOR SIZE		MOTOR	
<u>MOTOR TYPE</u>	<u>HORSEPOWER</u>	<u>SERVICE</u>	<u>VOLTAGE RATING</u>
Fractional and integral horsepower, 3-phase	1/2 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

2.5 TEMPERATURE RATING AND INSULATION

Motors shall be designed for continuous operation at the rated full load in an ambient temperature of 104 degrees F.

Insulation level shall be at least Class B.

2.6 MOTOR HOUSINGS

The motor housing shall have a smooth surface in the vertical, horizontal, and axial directions at each bearing housing for attaching a magnet mounted accelerometer in order to monitor the motor vibration. The surface shall be on the bearing housing. The axial surface will be as

close to the motor centerline as possible. The surface will have a finish of 63 micro-inch minimum. Diameter of finished surface shall be 2 inch minimum and must be corrosion resistant. As an option sand disks can be used to meet the smooth surface requirement. Disk shall have a minimum thickness of 3/8 inch.

Surface shall be level within 1 degree or .001 inch.

The smooth surface shall be identified(using a label or plate) "Vibration data collection point - Do Not Paint"

2.7 MOTOR ENCLOSURES

Motors installed in indoor, clean, dry, nonhazardous locations shall have open-type drip-proof enclosures. Enclosures shall have a hinged access cover at each vibration collection point. Cover must be large enough to enable the placement of a magnet/accelerometer data collection instrument.

Motors installed in indoor, nonhazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere shall be the totally enclosed type, with either of the following:

Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts.

2.8 SERVICE FACTOR

Service factor of general purpose and other open ac motors shall be in accordance with NEMA MG 1.

Totally enclosed ac motors shall have a service factor of 1.15.

2.9 FACTORY TESTS

Motors shall be factory-tested in accordance with the requirements of NEMA MG 1. Polyphase induction motors shall be factory-tested in accordance with IEEE Std 112, Method B. Tests shall consist of measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Routine tests on wound-rotor induction motors shall include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Electrical tests shall consist of winding resistance, insulation resistance, and high-potential tests. Certified copies of factory test results shall be submitted to the responsible systems engineer for approval prior to shipment from the factory. Previous test reports on identical motors are not acceptable for these tests.

PART 3 EXECUTION

3.1 INSTALLATION

Motors shall be installed, aligned, and connected in accordance with the equipment manufacturer's instructions.

Motors shall be bolt mounted. Motor feet shall be coplanar within 0.001 inch.

Base mounting points shall be accessible and adjustable to enable machine alignment. Motors over 7.5 hp shall have alignment jack bolts installed to enable alignment.

Alignment of motors shall be rechecked and adjusted as required after the motor has been in operation for not less than 48 hours.

3.2 ALIGNMENT

Before attempting alignment, the contractor will demonstrate that the load does not have any load/force imposed by the piping system. Minimum alignment values (below) are for motor and load at normal running temperatures. Values must be compensated for thermal growth. Limited movement of the motor or load (commonly known as bolt-bound) must be corrected to ensure alignment capability. Hold down bolts shall not be undercut in order to perform adjustment.

Shims shall be commercially die-cut, without seams or folds, and be made of corrosion resistant stainless steel. No more than four shims shall be used at any single point.

Motor and load shall be aligned to the following minimum specifications:

Speed(RPM)	close-coupled offset (mils)	close-coupled angle(mils/in.)	spool piece angle (mils/in. @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Motor/load alignment shall be performed under the direction of the manufacturer's representative.

Final alignment settings shall be provided as part of the final test data.

3.3 ELECTRICAL TESTS

Perform continuity test on all phases.

Perform insulation resistance and polarization index test on each phase of motor. Insulation tests on 480-volt and 600-volt motors shall be conducted using a 1000-volt insulation test set. Insulation tests on motors rated less than 480-volts shall be conducted using 500-volt insulation test set.

Test data shall include the location and identification of motors and megohm readings versus time. Test data shall be recorded at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Megohm readings shall not be less than 25 megohms for each phase and each phase

reading shall be within 10 percent of the other two.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. The polarization index shall be greater than 1.25. Any values lower shall be rejected and the motor returned to the factory.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16286

OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 MOTOR CONTROL
 - 2.1.1 Manual Motor Controllers
 - 2.1.2 Magnetic Motor Controllers
 - 2.1.2.1 Full-Voltage Controllers
 - 2.1.3 Combination Motor Controllers
 - 2.1.3.1 Two-Speed Combination Motor Controllers
 - 2.1.4 High-Voltage Motor Controllers
- 2.2 INSTRUMENT TRANSFORMERS
- 2.3 ENCLOSURES
 - 2.3.1 Equipment Enclosures
 - 2.3.2 Remote-Control Station Enclosures
- 2.4 CIRCUIT BREAKERS
 - 2.4.1 Molded-Case Circuit Breakers
- 2.5 FUSES
- 2.6 CONTROL DEVICES
 - 2.6.1 Magnetic Contactors
 - 2.6.2 Control-Circuit Transformers
 - 2.6.3 Magnetic Control Relays
 - 2.6.4 Pushbuttons and Switches
 - 2.6.4.1 Pushbuttons
 - 2.6.4.2 Selector Switches
- 2.7 INDICATING LIGHTS
 - 2.7.1 General-Purpose Type

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16286

OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.23 (1989) Electric Lamps - Incandescent
Lamps-Miscellaneous Types

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C63.2 (1987) Standard for Instrumentation -
Electromagnetic Noise and Field Strength,
10 kHz to 40 GHz - Specifications

IEEE C63.4 (1992) Methods of Measurement of Radio -
Noise Emissions from Low-Voltage
Electrical and Electronic Equipment in the
Range of 9 kHz to 40 GHz

JOINT INDUSTRIAL COUNCIL (JIC)

JIC-01 (1967) Electrical Standards for Mass
Production Equipment

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 107 (1987; R 1994) Methods of Measurement of
Radio Influence Voltage (RIV) of
High-Voltage Apparatus

NEMA 250 (1997) Enclosures for Electric Equipment
(1000 Volts Maximum)

NEMA AB 1 (1999) Molded Case Circuit Breakers and
Molded Case Switches

NEMA AB 3 (2001) Molded Case Circuit Breakers and
Their Application

NEMA FU 1 (1986; R 1996) Low Voltage Cartridge Fuses

NEMA ICS 1 (2000) General Standards for Industrial
Control and Systems

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

NEMA ICS 2	(1993) Industrial Control Devices and Assemblies
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems
NEMA SG 2	(1993) High-Voltage Fuses
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2002) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 489	(1996) UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 50	(1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment
UL 508	(1999) UL Standard for Safety Industrial Control Equipment

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical automated details.

Motor Controls
Instrument Transformers
Circuit Breakers
Fuses
Control Devices
Indicating Lights

Manufacturer's Catalog Data shall be submitted for the following items:

Motor Controls
Instrument Transformers
Enclosures
Circuit Breakers

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Fuses
Control Devices
Indicating Lights

SD-04 Drawings

Connection Diagrams shall be submitted showing the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Control Devices
Protective Devices

Fabrication Drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory.

Control Devices
Protective Devices

Installation Drawings shall be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices

SD-06 Instructions

Manufacturer's Instructions shall be submitted for the following items, including special provisions required to install equipment components and system packages. Special notices shall detail, resistance impedances, hazards and safety precautions.

Control Devices
Protective Devices

SD-09 Reports

Test Reports shall be submitted for the following tests on control and protective devices in accordance with the paragraph entitled, "Field Testing, of this section.

Operation Tests
Dielectric Tests

SD-13 Certificates

Certificates of Compliance shall be submitted for Circuit Tests on similar motor-control or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

SD-19 Operation and Maintenance Manuals

O&M Manuals shall be submitted for the following equipment:

- Manual Motor Controllers
- Magnetic Motor Controllers
- Combination Motor Controllers
- High Voltage Motor Controllers
- Circuit Breakers
- Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

No change in continuous-current rating, interrupting rating, and clearing or melting time of fuses shall be made unless written permission has first been secured from the Contracting Officer.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

Motor controllers shall conform to NEMA ICS 1, NEMA ICS 2, and UL 508. Controllers shall have thermal overload protection in each phase. Where indicated on drawings, reuse existing motor controllers. Replace existing thermal overloads inside existing magnetic motor controllers with size as required by replacement motor.

2.1.1 Manual Motor Controllers

Manual motor controllers for the control and protection of single-phase 60-hertz ac fractional-horsepower squirrel-cage induction motors shall be full-voltage, manually operated devices.

Controllers shall be single-throw, single- or double-pole, three-position devices rated not more than 1 horsepower at 115- and 230-volts single phase. Controller shall include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Controllers shall clearly indicate operating condition: on, off, or tripped.

Manual motor controllers shall be the toggle- or key-operated type as indicated and shall be arranged so that they may be locked with a padlock in the "OFF" position.

Recessed manual motor controllers for single-speed, fractional-horsepower squirrel-cage induction motors shall include a single controller and indicating light in a 4-inch square wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush cover plate. Surface-mounted manual motor controllers for single-speed, fractional-horsepower squirrel cage induction motors shall include a single controller and indicating light in a NEMA 250, Type 1 general-purpose enclosure.

Recessed and surface-mounted manual motor controllers for two-speed, fractional-horsepower squirrel-cage induction motors shall include two controllers, two indicating lights, and a selector switch in a multiple-gang wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush-cover plate. Surface-mounted manual motor controllers for two-speed fractional-horsepower squirrel-cage induction motors shall include two controllers, two indicating lights, and a selector switch in a NEMA 250, Type 1 general-purpose enclosure.

2.1.2 Magnetic Motor Controllers

2.1.2.1 Full-Voltage Controllers

Magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors shall be full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508.

Operating coil assembly shall operate satisfactorily between 85 and 110 percent of rated coil voltage. Motor control circuits shall be 120 volts, 60 hertz.

Controller shall be provided with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Solderless pressure wire terminal connectors shall be provided for line-and load-connections to controllers.

Overcurrent protection shall include three manual reset thermal overload devices, one in each pole of the controller. Thermal overload relays shall be melting-alloy type with continuous current ratings and service-limit current ratings and shall have a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

An externally operable manual-reset button shall be provided to re-establish control power to the holding coil of the electromagnet. After the controller has tripped from overload, resetting the motor-overload device shall not restart the motor.

Enclosure shall be in accordance with NEMA 250, Type 1.

2.1.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Combination motor controllers for the control and protection of single- and three-phase 60-hertz alternating-current squirrel-cage induction motors with branch-circuit disconnecting and protective devices shall be in accordance with NEMA ICS 1, NEMA ICS 2, and JIC-01.

Combination motor controllers shall include magnetic motor controllers and molded-case circuit breakers or MCP in metal enclosures in accordance with NEMA 250 or motor-control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

Magnetic motor controllers and enclosures shall be full-voltage, full-magnetic devices as specified in this section under paragraph entitled, "Remote-Control Station Enclosures."

Molded-case circuit breakers shall be thermal-magnetic breakers as specified in paragraph entitled, "Manual Motor Controllers." Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

Control-power transformers 120-volt ac maximum selector switches, pushbuttons, and pilot lights shall be as required.

Combination motor controllers shall be identified with identification plates affixed to front cover of the controller.

2.1.3.1 Two-Speed Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

Two-speed combination motor controllers for the control and protection of single- and two-winding, two-speed, three-phase, squirrel-cage induction motors shall include two magnetic controllers with molded-case circuit breaker or MCP, with selector switch or fast/slow/stop pushbutton and two indicating lights in the cover of the enclosure. Indicating lights shall indicate the high- and low-speed running connection of the motor controller.

Rating of three-phase, two-speed, full-voltage, magnetic controllers for nonplugging and nonjogging duty for constant- and variable-torque motors shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Rating of three-phase, two-speed, full-voltage, magnetic controllers for nonplugging and nonjogging duty for constant-horsepower motors shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Rating of three-phase, two-speed, full-voltage, magnetic controllers

for plug-stop, plug-reverse, or jogging duty for constant-torque, variable-torque, and constant horsepower motors shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

2.1.4 High-Voltage Motor Controllers

High-voltage motor controllers for the control and protection of squirrel-cage induction motors, wound-rotor induction motors, and synchronous machines rated 2.4 through 7.2 kilovolts, three-phase, shall be NEMA ICS 2, Class E2, type as required.

High-voltage motor controllers shall be housed in floor-mounted structures of the NEMA type indicated, with suitable draw-out compartments. Structure shall include provisions for padlocking the doors with Government furnished Key Interlock system.

The structure shall be subdivided into low-voltage compartment with separate door, high-voltage control compartment with separate door, AC bus compartment and top feed cable entrance compartment.

The controller shall be isolated by externally operated draw-out stabs with shutter mechanism. The isolating device shall also open the secondary of the control-power transformer. Interlocks shall be provided to prevent inadvertent operation of the isolating mechanism under load, opening the medium-voltage compartment door without isolating the starter, and closing the line contactor with door open. An isolating switch assembly shall be included.

The isolation switch handle shall have provisions for three padlocks in the off position.

Controllers shall be the fused type employing current-limiting power fuses of the interrupting rating 200 MVA. Single-phase antitrip protection shall be provided. Starters shall employ vacuum break contactors rated not less than 5 kilovolts. The control circuit shall have provisions for external testing of 120-volt control circuit and a minimum of two sets of normally open and normally closed auxiliary contacts shall be provided.

The current-limiting power fuses shall be of self-protecting type with visible fuse conditions and indicators, and with time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. The power fuses shall be mounted in such a manner permitting easy inspection and replacement without starter disassembly. Three spare fuses shall be provided for each starter, and shall be stored in switch compartment.

The starter shall be designed to accommodate chiller motor of the size and type as shown on the contract drawings. Unless otherwise noted, the type of starting shall be across the line with minimum 400 ampere contactor.

Current transformers shall be provided and sized as required for the chiller and starter.

See mechanical specifications Section 15626 for centrifugal water chiller

requirements.

Programmable motor overload protection system shall be provided in the new starter, and shall consist of a solid-state, multi-function, motor protective relay. The multi-function, motor protective relay shall be capable of monitoring three phase ac current, receive command from remote source either by contact closures or digital data, give command to motor starter, capable of transmitting all data to remote computer through two wire local area network (RS232 format), and make separate trip and alarm decisions based on pre-programmed motor current (stored in a non-volatile memory).

The programmable motor protection panel shall be semiflush-mounted to the hinged instrument panel of the low voltage compartment and shall have matching cover.

2.2 INSTRUMENT TRANSFORMERS

Instrument transformers shall comply with the interference requirements listed below, measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107.

MECHANICAL / ELECTRICAL MODIFICATIONS - CENTRAL COMPUTING COMPLEX

Insulation Class, kV	Basic Insulation Level, kV	Preferred Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Radio Influence Voltage Level, <u>Microvolts</u>	
					Dry Type	Oil Filled
0.6	10	0.76	250	250
1.2	30	0.208 0.416 0.832 1.04	0.132 0.264 0.528 0.66	0.76	250	250
2.5	45	2.40	1.52	1.67	250	250

2.3 ENCLOSURES

2.3.1 Equipment Enclosures

Enclosures for equipment shall be in accordance with NEMA 250.

Equipment installed in industrial locations shall be contained in NEMA Type 12 industrial use, sheet-steel enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Sheet-steel enclosures shall be fabricated from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Ferrous-metal surfaces of remote-control-station enclosures shall be cleaned, phosphatized, and painted with the manufacturer's standard finish.

2.3.2 Remote-Control Station Enclosures

Remote-control station enclosures for pushbuttons, selector switches, and indicating lights shall be in accordance with the appropriate articles of NEMA ICS 6 and NEMA 250.

Remote-control stations installed in industrial locations shall be contained in NEMA Type 12 industrial-use, cast-iron enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Remote-control stations shall be installed with the centerline 66 inches above the finished floor.

2.4 CIRCUIT BREAKERS

Circuit breakers shall conform to UL 489, NEMA AB 1, and NEMA AB 3.

2.4.1 Molded-Case Circuit Breakers

Circuit breakers shall be molded case, manually operated, trip-free, with

inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.

Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 22,000 amperes and shall conform to NEMA AB 3.

Multipole circuit breakers shall be of the common-trip type having a single operating handle and a two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 104 degrees F. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of NFPA 70 and shall be of the motor-circuit protector type.

Circuit breakers used for service disconnection shall be the enclosed circuit-breaker type with external handle for manual operation. Enclosures shall be sheet metal with a hinged cover suitable for surface mounting.

2.5 FUSES

A complete set of fuses for all switches and switchgear shall be provided. Fuses shall have a voltage rating not less than the circuit voltage.

Fuses rated 30 amperes, 125 volts or less shall be the nonrenewable cartridge type. Fuses rated above 30 amperes 600 volts or less shall be the renewable cartridge type with time-delay dual elements, except where otherwise indicated. Fuses shall conform to NEMA FU 1.

Special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses shall be installed where required. Plug fuses are not permitted.

Power fuses on ac systems above 600 volts shall be in accordance with NEMA SG 2.

Fuses shall be labeled showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, fuse information shall be clearly listed on equipment drawings.

Fuse holders field-mounted in a cabinet or box shall be porcelain. Field installation of fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber shall not be used.

2.6 CONTROL DEVICES

2.6.1 Magnetic Contactors

Magnetic contactors for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers shall be in accordance with NEMA ICS 1 and NEMA ICS 2 as required.

Core-and-coil assembly shall operate satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Contactor shall be designed with a normally open holding circuit auxiliary contact for control circuits. Rating of the auxiliary contact shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Solderless pressure wire terminal connectors shall be furnished or made available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Rating of magnetic contactors shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

2.6.2 Control-Circuit Transformers

Control-circuit transformers shall be provided within the enclosure of magnetic contactors and motor controllers when the line voltage is in excess of 120 volts. Transformer shall be encapsulated dry type, single-phase, 60-hertz, with a 120-volt (or 24-volt) isolated secondary winding.

Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.

Voltage regulation of the transformer shall be such that, with rated primary voltage and frequency, the secondary voltage shall not be less than 95 percent nor more than 105 percent of rated secondary voltage.

Source of supply for control-circuit transformers shall be the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits with fuses selected in accordance with JIC-01. Secondary winding

of the control-circuit transformer shall be grounded in accordance with JIC-01.

2.6.3 Magnetic Control Relays

Magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices in response to variations in the conditions of electric control devices shall be in accordance with NEMA ICS 1, and NEMA ICS 2.

Core-and-coil assembly shall operate satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Relays shall be designed to accommodate normally open and normally closed contacts.

Magnetic control relays shall be 120-volt, 60-hertz, Class AIB devices with a continuous contact rating of 10 amperes and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.6.4 Pushbuttons and Switches

2.6.4.1 Pushbuttons

Pushbuttons for low-voltage ac full-voltage magnetic controllers shall be heavy-duty oiltight NEMA 250, Type 12, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Color code for pushbuttons shall be in accordance with JIC-01.

Pushbuttons shall be designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Pushbutton-contact ratings shall be in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

2.6.4.2 Selector Switches

Selector switches for low-voltage control circuits shall be heavy-duty oiltight maintained-contact devices with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Selector switches in remote control stations shall be identified with engraved identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.7 INDICATING LIGHTS

2.7.1 General-Purpose Type

Indicating lights shall be oiltight instrument devices with threaded base

and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with ANSI C78.23. Color code for indicating lights shall be in accordance with JIC-01.

Indicating lights shall be provided in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

PART 3 EXECUTION

3.1 INSTALLATION

Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

3.2 FIELD TESTING

Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.

Ratio tests and tap settings shall be verified for instrumentation, potential, and current transformers.

Control and protective devices shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16345

MOTOR CONTROL

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS
- 1.4 SHIPPING

PART 2 PRODUCTS

- 2.1 EQUIPMENT
- 2.2 CONFIGURATION
- 2.3 CONSTRUCTION
- 2.4 COMBINATION MOTOR-CONTROL UNITS

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 FIELD TESTING

-- End of Section Table of Contents --

SECTION 16345

MOTOR CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control Devices and Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 845 (1995; 4th Ed; Aug 1, 1989) UL Standard for Safety Motor Control Centers

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," and Section 16286, 'Overcurrent Protective Devices', apply to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Motor-Control Centers
Motor Control Units
Accessories

SD-04 Drawings

Connection Drawings shall be submitted showing the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and

other devices.

Control Devices
Protective Devices

SD-06 Instructions

Manufacturer's Instructions shall be submitted for the following including special provisions required to install equipment components and system packages. Special notices shall detail hazards and safety precautions.

Control Devices
Protective Devices

SD-13 Certificates

Certificates of Compliance shall be submitted for Circuit Tests on similar motor-control or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

1.4 SHIPPING

Motor-control centers longer than 8 feet shall be shipped in coordinated subassemblies for field connection. Maximum shipping length shall be as approved.

PART 2 PRODUCTS

2.1 EQUIPMENT

Motor-control centers shall conform to NEMA ICS 2, UL 845 and NFPA 70.

2.2 CONFIGURATION

Motor-control centers shall be NEMA ICS 2, Class I, Type C, totally enclosed, free-standing, dead-front distribution type with one or more vertical sections in which combination motor-control units, transformers, panels, and associated control equipment units are group-mounted in an integrated assembly.

2.3 CONSTRUCTION

Motor-control centers shall be accessible from the front only.

Provisions shall be made for leveling the entire assembled motor-control center sections and bolting them together so that they form a contiguous structural enclosure.

Motor-control centers shall contain electrical interlocks, unit control terminal blocks, master control terminal blocks, unit wiring to terminal blocks and unit interconnections, and power connection terminal blocks as required.

Covers for motor-control centers shall be fabricated from cold-rolled carbon-steel sheets of commercial quality with stretcher-level flatness. Vertical sections shall be reinforced to form a rigid structure.

Lifting angles shall be 7 gage, shall be provided on the top of each section, shall extend the entire width of the section, and shall be capable of supporting the entire weight of the motor-control center section without distortion. Base channels shall be provided with holes to facilitate floor mounting and leveling.

Design of the motor-control centers shall allow addition of sections with the same height and width without major modifications. Top cover shall not sag or be deformed.

Top and sides shall have removable covers secured with bolts or fasteners. Covers shall permit access from the rear to the main bus and bus-tap connections in each vertical section. Access doors to motor-control drawout units, wiring channels, and the protective cover of the main horizontal bus shall provide dead front construction.

Horizontal wiring channels shall be provided in the top and bottom of motor-control centers for wiring between vertical sections. Wiring channels shall extend the entire length of the motor-control center and shall allow space for duct and conduit entrances. Horizontal wiring channels shall provide a minimum of 90 square inches of unobstructed wiring space. Vertical wiring channels shall be provided in each vertical section for side wiring to individual motor-control units. Vertical wiring channels shall extend the entire length of each vertical section. The minimum dimensions of the vertical wiring channel shall be 4-3/8 inches wide and 7 feet deep. Covers of motor-control units and vertical wiring channels shall be side-hinged to the vertical section and fastened in the closed position with captive bolts, screws, or latches. Horizontal wiring channel covers shall be removable and fastened in place with captive bolts or screws. The horizontal and vertical wiring channels shall be isolated from all buses. In each section, the vertical and horizontal wiring channels shall open to the front to allow wires to be laid in place.

Terminal blocks shall be provided in each section of the motor control center.

Horizontal bus structure shall extend the entire length of the motor-control center and shall be tinned copper with a continuous rating of 1600 amperes.

All vertical sections shall be completely bused (600-ampere rating) and electrically interconnected with tin-plated solid copper busbars to accommodate plug-in starter units with main horizontal and vertical buses uniformly positioned and phase sequenced. Main horizontal buses shall be readily accessible for connection of future vertical sections at either end.

Vertical sections shall have a width not less than 20 inches.

Buses shall be supported and braced to withstand the short-circuit currents

indicated. Contact surfaces of main buses shall be silver plated and bolted together to ensure conductivity.

A main incoming circuit breaker compartment shall be provided. The main circuit breaker shall be inverse time thermal magnetic type. It shall be front accessible and have a removable protective barrier to reduce the possibility of accidental contact with line terminals.

A continuous rigid tin-plated copper ground bus shall extend through the bottom of the entire assembly and shall ground the stationary structure and equipment. Ground bus shall be capable of carrying the rated short-circuit current available in the motor-control center.

After fabrication, steel surfaces of motor-control centers shall be cleaned and phosphatized prior to the application of paint. External and internal surfaces shall be finished with baked enamel or a fast air-drying enamel. Color of internal finishes shall be as indicated in Section 16003, "General Electrical Provisions." Nonpainted parts shall be cadmium plated or coated with zinc chromate.

2.4 COMBINATION MOTOR-CONTROL UNITS

Combination motor-control units for the control and protection of single-and three-phase, 60-hertz squirrel-cage induction motors with branch-circuit disconnection and protective devices shall include magnetic motor-controllers, molded-case circuit breakers, or motor-control circuit protectors in compartmentalized draw-out unit construction with fused control-power transformers, selector switches, pushbuttons, and indicating lights, as indicated. Motor control and protective devices shall conform to the requirements of Section 16286, "Overcurrent Protective Devices."

Unit spaces in vertical sections shall be provided with guide rails for the support and alignment of motor-control draw-out units. Latches shall be provided to ensure complete electrical connection of the draw-out unit with the main bus and to allow removal of the draw-out unit from the motor-control center. Plug-in units shall be interchangeable.

Draw-out unit shall be provided with spring-loaded, silver-plated, plug-in stabs for connection to the main bus on the line side of the motor-control unit and fixed terminal blocks for the load-side connections. Wiring shall be accessible from the front. No wiring shall extend into the bus compartment. Unit terminal blocks shall be the split type, allowing unit removal without disturbing outgoing wires.

Motor-control units shall be provided with a single separate hinged door interlocked with its associated disconnecting device to prevent access to draw-out units when the circuit breaker contacts are closed and the operating handle is in the "ON" position. Doors shall swing open a minimum of 112 degrees. An interlock release shall be provided, however, to defeat the interlocking mechanism and permit access to the draw-out unit using a simple hand tool.

Doors shall be provided with openings for the operating handle of molded-case circuit breakers, thermal-overload relay reset buttons,

indicating lights, selector switches, and pushbuttons as required.

Disconnect switch overload reset button, selector switches, and any indicating lights and pushbuttons shall be operable with the compartment door closed. The ON-OFF position of the main disconnect method shall be clearly indicated with the door closed.

Feeder tap units shall include externally operable molded-case circuit breakers in combination motor-control unit enclosures for the protection of non-motor loads or remotely located magnetic motor-controllers. Not more than two molded-case circuit breakers shall be contained in feeder tap units.

Compartments for future combination motor-control units shall be complete with hardware, buses, and hinged doors ready to receive future draw-out units. Compartments for spare combination motor-control units shall be complete with buses, hinged doors, and draw-out units but without load terminal connections. Spare spaces shall be complete with buses and screwed-on front cover plates.

Combination motor-control units shall be identified with identification plates affixed to the front hinged door or cover plate of each compartment. Identification plate shall identify the connected load.

Control devices, interlocks, and interface with remote devices shall be provided as indicated on the contract drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Complete assembly shall be electrically and mechanically connected and assembled from coordinated subassemblies shipped in complete sections from the manufacturer. Installation shall be aligned, leveled, and secured to the supporting construction in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

Motor-control centers shall be subjected to continuity and insulation tests after the installation has been completed and before the motor-control center is energized.

Contractor shall provide test equipment, labor, and personnel to perform the tests required. Continuity tests shall be conducted using a direct current (dc) device with bell or buzzer.

Motor-control centers shall be completely isolated from extraneous electrical connections. Substation feeder breakers, circuit breakers in switchboards, and other disconnecting devices shall be used to isolate the motor-control center under test.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical

connections to motors and other connected equipment shall be clockwise.

Test data shall be recorded and shall include location and identification of motor-control centers and megohm readings versus time.

Final acceptance shall depend upon the satisfactory performance of the motor-control centers under test. No motor-control center shall be energized until recorded test data have been approved by the Contracting Officer.

-- End of Section --